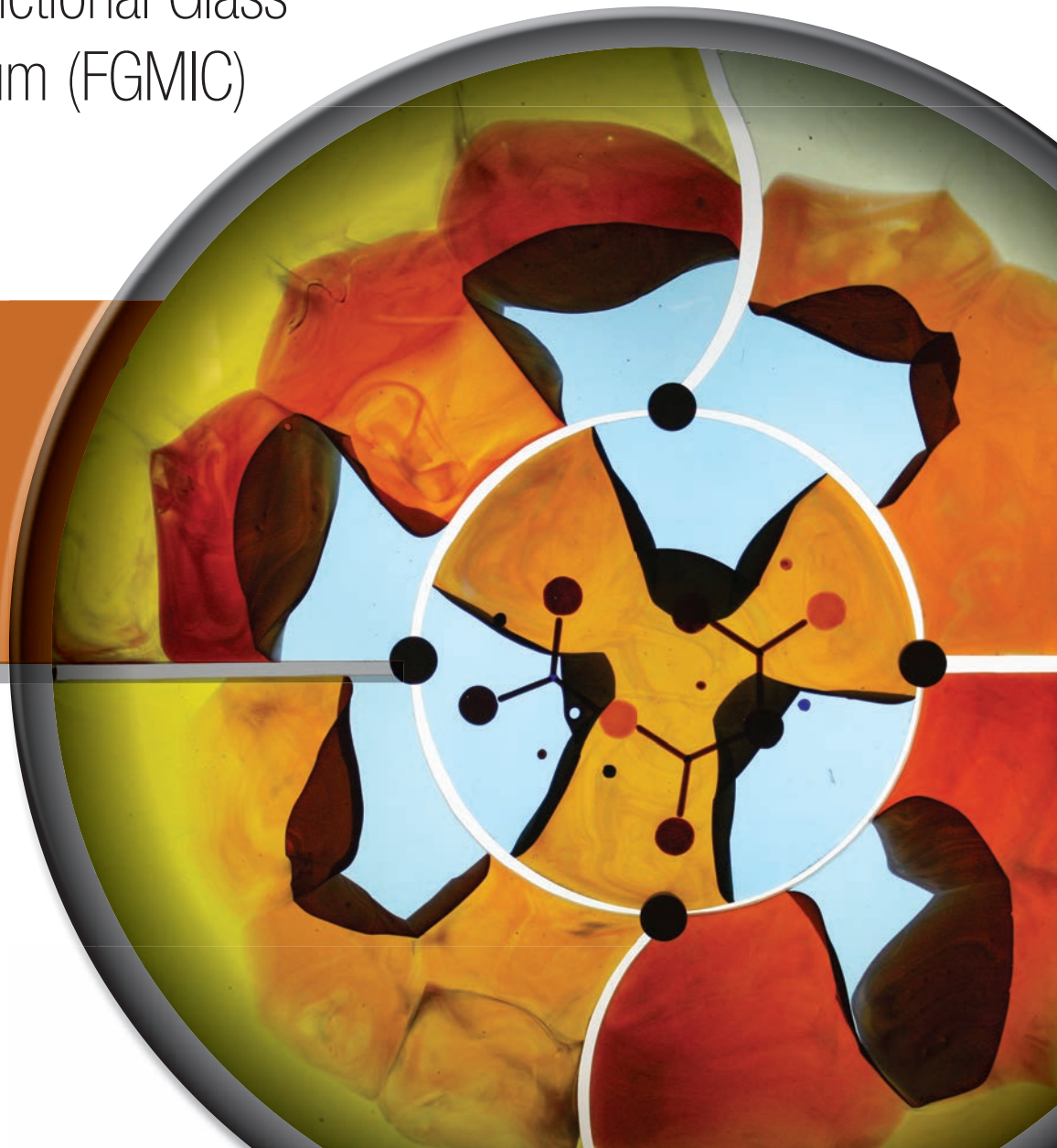
GLASS INDUSTRY RESOURCE GUIDE TO CONSORTIUMS AND ORGANIZATIONS

The American Ceramic Society Functional Glass Manufacturing Innovation Consortium (FGMIC)



Report and Research Findings
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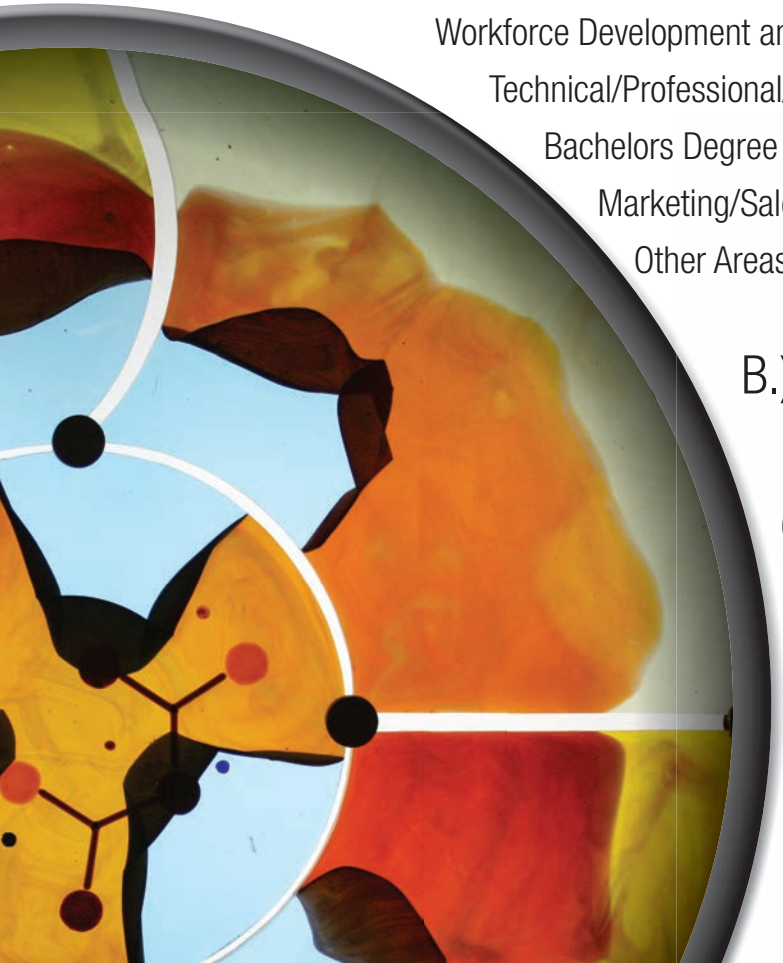


PART A

EVALUATION OF SUCCESSFUL CONSORTIA WITH SIMILAR MISSION, SCOPE, AND INDUSTRY SIZE

(i.e., comparable successful examples to model)

A.) Functional Glass-Industry-Specific Assets: Existing Consortiums and/or Similar Missioned Programs from Around the World

GENERAL, WIDE-ENCOMPASSING GLASS ORGANIZATIONS/INITIATIVES

G-1.) Glass Manufacturing Industry Council—http://gmic.org/

SYNOPSIS

GMIC is a 501(c)(6) nonprofit trade association representing the interests of the glass manufacturing industry. GMIC bridges all segments of glass manufacturing, including float, container, fiber, and specialty glasses. GMIC does for individual companies what they would find difficult to do on their own: provide technical education; coordinate technical initiatives; provide industry intelligence; develop workforce; advocate with law makers; promote the use and image of glass products; and provide opportunities to meet and exchange ideas. Incorporated in 1998, the council is governed by a board of trustees with offices in Westerville, Ohio. Through extensive interviews with chief executives and technical managers of the glass manufacturing industry, the GMIC Board of Trustees created a set of strategic objectives. These objectives drive the annual operational objectives and serve as the road map for future development:

- Promote and facilitate the use of glass;
- Position the industry to better meet sustainability demands; and
- Represent the glass industry.

RESEARCH PROGRAMS (IF ANY)

GMIC has hosted a significant number of research programs spearheaded by academic and industry organizations. These research programs have resulted in successful technology transfer and real deployments of technologies (see below for more details).

MANUFACTURING DEMO PROGRAMS (IF ANY)

Libbey and Rio Tinto have been the primary industrial supporters of everything from furnace improvement projects and real-world demonstrations to sensor developments monitoring these assets. PaneraTech, a small Ohio-based business developing sensors for smelting monitoring, actually commercialized the technology based on tests in the Libbey furnace facilities.

IP POLICIES (IF ANY)

Companies tend to own IP developed.

MEMBERSHIP/BUSINESS MODEL

The membership is tiered, i.e., membership dues are based on company size and category.

MEMBERS

Anheuser Busch, CertainTeed, Corning, Hollingsworth & Vose Fiber Co., Johns Manville, Libbey, Owens Corning, O-I, Pittsburgh Corning, Gallo Glass, PPG, World Kitchen, Eurotherm, Elster, Linde Group, Rio Tinto, Nalco, PraxAir, Unimen, TECO, et al.

HQ BASED

Westerville, Ohio, USA.

NOTES

This organization is the closest to performing vast industry-relevant R&D and manufacturing demonstrations of any other organization. Many of its efforts focus on glass-specific asset improvements, recycling of glass, and manufacturing process improvements.

G-2.) American Architectural Manufacturers Association—www.aamanet.org

SYNOPSIS

AAMA is a trade association of manufacturers and suppliers of residential, commercial, and architectural windows, doors, skylights, and other fenestration products. AAMA is involved in developing industry standards, test methods, and performance criteria for certified window and door products and components. AAMA specifically hosts a Glass Material Council, which includes many assets, including education, standards, marketing, and edge pressure R&D. AAMA also has a technical alliance with IGMA and GANA, especially on glazing and sound control of glass windows.

RESEARCH PROGRAMS (IF ANY)

The Glass Material Council has a task force exclusively focused on edge pressure concerns and solutions.

MANUFACTURING DEMO PROGRAMS (IF ANY)

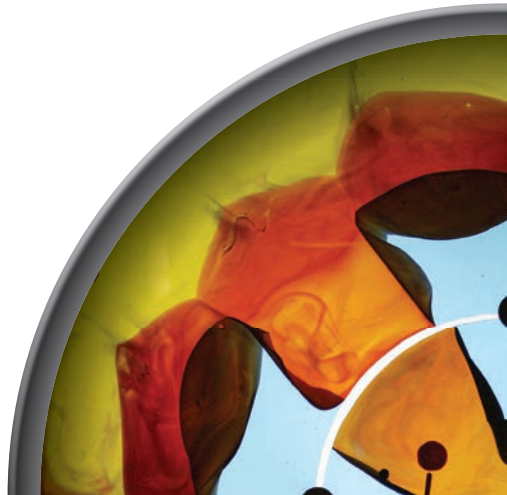
N/A.

IP POLICIES (IF ANY)

N/A.

MEMBERSHIP/BUSINESS MODEL

Membership.



MEMBERS

Specific large members of the Glass Material Council include Dow, Eastman, Pella, Arkema, and Jel-Wen. See http://members.aamanet.org/sbaweb/common/councilrosterlist.asp?comcd=GMC.

HQ BASED

Schaumburg, Ill., USA.

NOTES

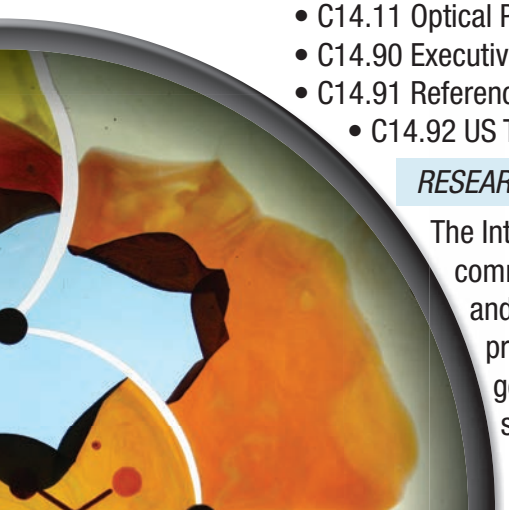
Technical specifications at http://members.aamanet.org/sbaweb/common/councilrosterlist.asp?comcd=GMC. Joint technical data for glass windows at http://www.glassdocs.com/.

G-3.) ASTM International—www.astm.org

SYNOPSIS

Formerly American Society for Testing and Materials, ASTM International is involved in establishing test methods and guidelines for all types of materials, including glass products. It has a particular committee (C14) on Glass and Glass Products. The committee is responsible for the development of test methods, analysis methods, specifications, standards practices, nomenclature, definitions, and the stimulation of research relating to glass and glass products. Committee C14, with the current membership of approximately 141, has jurisdiction of 62 standards. Glass topics include

- C14.01 Nomenclature and Definitions;
- C14.02 Chemical Properties and Analysis;
- C14.04 Physical and Mechanical Properties;
- C14.05 Glass Pipe;
- C14.07 Glass Containers;
- C14.08 Flat Glass;
- C14.10 Glass Decoration;
- C14.11 Optical Properties;
- C14.90 Executive;
- C14.91 Reference Materials; and
- C14.92 US TAG to TC 160 Glass in Buildings.



RESEARCH PROGRAMS (IF ANY)

The Interlaboratory Study Program (ILS) is part of ASTM's continuing pursuit of excellence in standards development. ASTM made a commitment to fund the development of the ILS Program in response to the need for standards in the marketplace to be of known and documented quality. This commitment means that ASTM has been able to assist those technical committees for which the prospect of implementing an interlaboratory study was either administratively daunting or financially impossible. The ultimate goal is to enhance the quality of ASTM standard test methods by aiding the Technical Committees as they develop precision statements backed by high-quality laboratory data. Current glass-related R&D projects underway include Test Method for Cor-

rosion Test for Engine Coolants in Glassware and Test Method for Corrosion Test for Heat Transfer Fluids in Glassware. ASTM has published approximately 6,000 test methods to date, and others are under consideration. The backbone of many of these standard test methods is a comprehensive interlaboratory study that supports the Precision and Bias statement.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A—this is an organization more about standards, not products/technologies.

IP POLICIES (IF ANY)

N/A—although unlikely when you look at the above ILS process steps on their website. ASTM seems to make these results open and free to the public.

MEMBERSHIP/BUSINESS MODEL

Membership ($75 for individuals and $400 for organizations) as well as education and conferences

MEMBERS

There is a long list of corporate organizations—nearly every well-known product-based Fortune 100 company is an organization member.

HQ BASED

West Conshohocken, Pa., USA.

NOTES

See https://www.astm.org/COMMIT/C14_Factsheet.pdf. Specifics on the ILS (R&D) program at https://www.astm.org/ILS/faq.html.

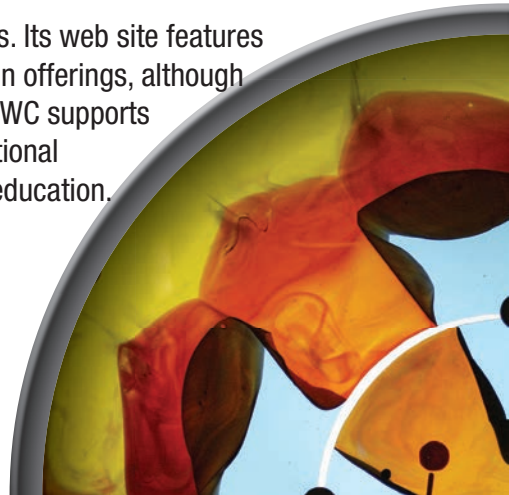
G-4.) Efficient Windows Collaborative—www.efficientwindows.org

SYNOPSIS

EWC is a consortium of window and door manufacturers and other organizations supporting the use of energy-efficient windows. Its web site features much useful information about window energy performance issues, getting technical on material trends, and providing education offerings, although it does not host a large trade show/conference. The consortium tends to keep activities of the organization small and focused. EWC supports and partners the Consortium for Energy Efficiency, National Fenestration Rating Program, ENERGY STAR, Lawrence Berkeley National Laboratory, and other programs by developing technical criteria, participating in research projects, and providing outreach and education. The group does an excellent job of aggregating tax and other financial incentives for using efficient windows.

RESEARCH PROGRAMS (IF ANY)

N/A—the consortium tends to aggregate information from DOE and other R&D efforts for this group.



MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A

IP POLICIES (IF ANY)

None, because no R&D is conducted.

MEMBERSHIP/BUSINESS MODEL

Type	Annual Membership Dues
Manufacturer, Large (> $50M in sales)	$2000
Manufacturer, Medium ($5–$50M in sales)	$1500
Manufacturer, Small (< $5M in sales)	$1000
Each Manufacturer Subsidiary	$300
Reseller, Large (> $50M in sales)	$2000
Reseller, Medium ($5–$50M in sales)	$1500
Reseller, Small (< $5M in sales)	$1000
Supplier, Large (> $100M in sales)	$2000
Supplier, Medium ($10–$100M in sales)	$1500
Supplier, Small (< $10M in sales)	$1000
Each Supplier Subsidiary	$300
Affiliates, Medium & Large (> $1M in sales)	$1000
Affiliates, Small (< $1M in sales)	$500
Affiliates, NGO/Non Profit Organizations	No fees
Affiliates, Research/Academia	No fees
Affiliates, Trade/Professional Associations	No fees

Efficient Windows Collaborative Membership Agreement (revised 5/2016)

MEMBERS

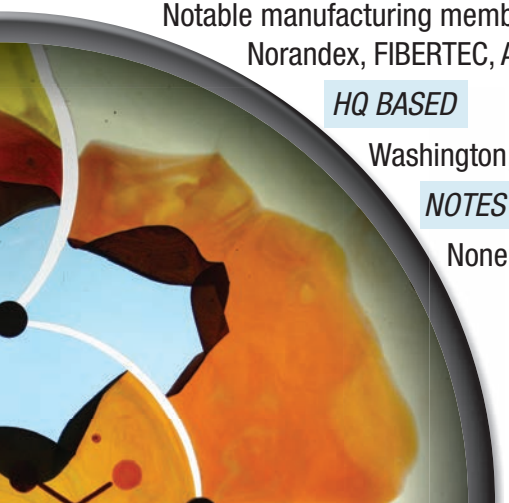
Notable manufacturing members include (glass producers) Cardinal, Guardian, Pilkington, and PPG/Vitro and (insulated glass influencers) Thermo-Tech, Norandex, FIBERTEC, Associated Materials Inc., and Andersen. Complete membership list at http://www.efficientwindows.org/membership_list.php.

HQ BASED

Washington, D.C., USA.

NOTES

None.



G-5.) Insulating Glass Certification Council—www.igcc.org

SYNOPSIS

IGCC is a nonprofit organization representing manufacturers, consumers, specifiers, and others concerned with the quality and performance of insulating glass units. It sponsors and directs an independent, true third-party certification program. IGCC provides periodic accelerated laboratory tests, per ASTM specifications. Started in 1977, this concerned group recognized the need for a sound product testing and performance certification program, with equal representation of business community and public interests, managed by a highly professional and efficient, independent third-party administrator. To safeguard against undue industry influence, the agreement of the public representatives on the IGCC Board of Governors is required for the adoption of all IGCC Board actions. Expert third-party administration is provided by a professional certification program management firm. The IGCC certification program is predicated on the concept of independent and impartial administration of periodic accelerated laboratory testing and unannounced plant inspections to ensure continuing quality product performance. IGCC maintains a current and flexible attitude concerning technological changes by developing guidelines to implement the ASTM standard in light of new technology. These guidelines are developed in open, due-process discussions and apply fairly to all participants in the same manner. Buyers can find a list of the certified products front and center in the group's website.

RESEARCH PROGRAMS (IF ANY)

Although this group does not conduct R&D outright, it has a significant certification purpose that observes and aggregates much technical data on the performance and manufacturing quality of ever-technologically-changing insulated glass materials. Therefore, the group posts an updated list of third-party testing laboratories and a pricing list for the particular tests they offer (i.e., ASTM durability standards, gas content of airspace, etc.). The group meets annually with IGMA—an organization more deeply rooted in R&D efforts within the insulating glass sector.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

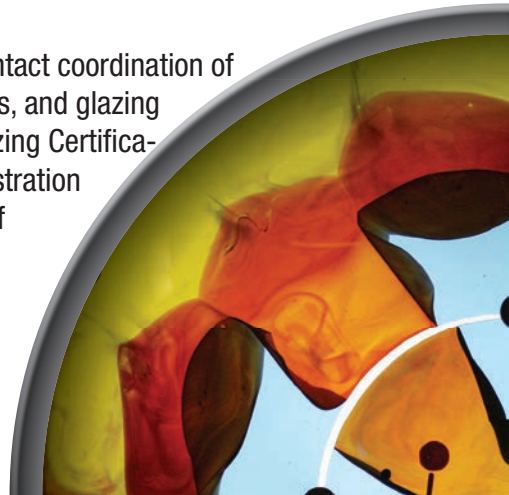
None, because the group hosts no R&D collaborative projects.

MEMBERSHIP/BUSINESS MODEL

No membership. IGCC is a subsidiary of Administrative Management Systems Inc., a for-profit company that provides single-contact coordination of certification and inspection services between fabricators and installers of fenestration products (glass, windows, doors, skylights, and glazing systems) and nationally recognized associations, such as the Window and Door Manufacturing Association (WDMA), Safety Glazing Certification Council (SGCC), Insulating Glass Certification Council (IGCC), Insulating Glass Manufacturer's Alliance (IGMA), National Fenestration Rating Council (NFRC), and the North American Contractors Certification (NACC) program. It appears to operate under portions of certification payments by manufacturers to third-party laboratories, etc. The company brokers throughout these industries.

MEMBERS

None, because it is not a membership-based organization.



HQ BASED

Sackets Harbor, N.Y., USA.

NOTES

Main company—http://www.amscert.com.

G-6.) Insulating Glass Manufacturers Alliance—www.igmaonline.org

SYNOPSIS

IGMA is a leading organization involved in the engineering and manufacturing of insulating glass. IGMA is the trade association representing the interests of the insulating-glass industry worldwide. It focuses on developing and advancing new technologies in the manufacture of insulating glass units through development of codes and standards, topic industry publications, education, product certification, and leading-edge research. The organization has a strong industrial base and offers educational opportunities, publications, and many technical-heavy programs for all things insulated glass related. Members and the general public can access research presentations on materials, glazing, and process innovations. The organization is ISO 9001:2008 certified. The organization also hosts a robust leadership management training program, regardless of glass content.

RESEARCH PROGRAMS (IF ANY)

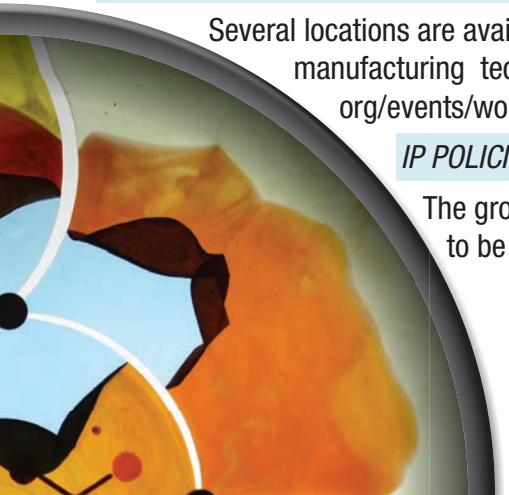
All manufacturing and supplier members are asked to provide $200 for a "R&D fund" that helps fund internal programs. It appears most R&D projects are headed by the Emerging Technology and Innovation Committee, and, when annual gatherings occur, the Committee breaks down into further task groups to work through activities in such areas as gas permeability, vacuum-insulated glazing, and advanced fenestration. Testing is led by NREL (National Laboratory). These task groups partner with key government organizations and industry to advance the understanding, guidelines, testing, certification, and proper use of innovative insulating-glass technology.

MANUFACTURING DEMO PROGRAMS (IF ANY)

Several locations are available, and members may attend workshops and conferences hosted at various sites to experience hands-on training of manufacturing techniques/processes. An example is a large, industrial insulating glass test lab of IGMA's programs. See http://www.igmaonline.org/events/workshop/.

IP POLICIES (IF ANY)

The group is committed to R&D and innovative practices, because many of its efforts focus on technical best practices. There appears to be no formal IP protective measures for members and these efforts, even with the R&D fund in place.



MEMBERSHIP/BUSINESS MODEL

IGMA is membership based, but publications and education workshops/conferences also can be purchased for between $300 and $2,000 (and also have many sponsorship opportunities).

Manufacturing Members (annual production all plants, square footage)		Supplier Members (annual sales to the industry)	
0 to 750,000	USD $1,400	$0 - $1,499,999	USD $2,500
750,000 to 1,500,000	USD $2,200	$1,500,000 - $2,499,999	USD $3,400
1,500,000 to 3,000,000	USD $2,900	$2,500,000 - $9,999,999	USD $4,100
+ 3,000,000	USD $5,100	$10,000,000 - $24,999,999	USD $4,700
Primary Glass Manufacturer	USD $9,500	Over $25,000,000	USD $5,300
Additional location fee @ $250		Corporate	USD $7,900
		Associate Member	USD $600
Research and Development fund *(applicable to Manufacturing and Supplier Members)*	USD $200	Auditing & Testing Labs	USD $2,200
NOTE: All membership fees are payable in USD. Membership fees will be invoiced in January of each year.			

MEMBERS

Notable industrial members include Cardinal, Guardian, Pilkington, PPG/Vitro, Shaw, Dow Corning, and Ensinger. Complete list can be found at http://www.igmaonline.org/about/members.asp.

HQ BASED

Chicago, Ill., USA..

NOTES

A list of research topics/areas of innovation at http://www.igmaonline.org/technical/; publications and their pricing at http://www.igmaonline.org/publications/; and technical committees (right side of webpage) at http://www.igmaonline.org/about/. 2015 examples of technical areas of interest to IGMA at http://www.usglassmag.com/2015/10/igma-kicks-off-with-emerging-technology-and-innovation/.

G-7.) Glass Association of North America—http://www.glasswebsite.com/

SYNOPSIS

GANA is the leading association serving flat-glass manufacturers, fabricators, and glazing contractors. GANA is a progressive, innovative association where pride and enthusiasm for a career in architectural glass and glazing is fostered through educational events, technical resource development, and relationship-building opportunities. GANA is comprised of more than 300 member companies from across North America. The organization is divided into topic areas, including flat-glass manufacturing, energy, and tempering. It also hosts large conferences and offers publications.

RESEARCH PROGRAMS (IF ANY)

GANA has a foundation that raises funding for research grants and hosts studies of interest to the field. It appears these grants solicit a particular echelon of funding (i.e., either above or below $2,000) that enables a company's logo to be placed on the study as well as any ensuing press materials released. GANA has one open research project that is an in-depth study on high-performance glazing.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

At least when it comes to the research grants, there appears to be no IP promised to funders.

MEMBERSHIP/BUSINESS MODEL

Membership and some education/publication fees.

MEMBERS

The members are broken down into various divisions, but of most interest is the flat-glass manufacturing division, with notable members, such as Guardian, Pilkington, SCHOTT, Eastman Chemical Company, and PPG. Full members list at http://web.glasswebsite.com/search.

HQ BASED

Topeka, Kans., USA.

NOTES

None.

G-8.) Glass Packaging Institute—http://www.gpi.org/

SYNOPSIS

Founded in 1919 as the Glass Container Association of America, GPI is the trade association representing the North American glass container industry. On behalf of glass container manufacturers, GPI promotes glass as the optimal packaging choice, advances environmental and recycling policies, advocates industry standards, and educates packaging professionals. Education programs seem to focus exclusively on university-level packaging students. Programs include workshops, integrated curriculum with schools with packaging curriculum, plant tours, and providing old mold sets. Another major asset of the organization is advocacy for this industry, especially on recycling and hazard standards. To back the recycling advocacy, in December 2008, GPI announced that its member companies were committed to achieving the goal of using at least 50% recycled glass in the manufacture of new glass bottles and jars by 2013. This report provides a comprehensive account of the robust efforts taken by the glass packaging industry to achieve this goal.

RESEARCH PROGRAMS (IF ANY)

GPI has something similar to a research program, but it really is an advisory council on all things deeply scientific. The Science Advisory Board (SAB) of GPI is composed of three academic scientists who provide independent, science-based interpretations and assessments of current scientific issues and research relevant to the packagingindustry. The members of the SAB critically review data, publications, and government reports with respect to the safety and health consequences of the use of food and beverage packaging materials, upon request by GPI, and advise GPI and its members with respect to these issues. Any public statements or reports by the SAB or any individual members are independently determined by the SAB and its members.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

N/A.

MEMBERSHIP/BUSINESS MODEL

Crystal, $20,000; Emerald, $7,500; Amber, $5,000; and Friend, $1,500.

MEMBERS

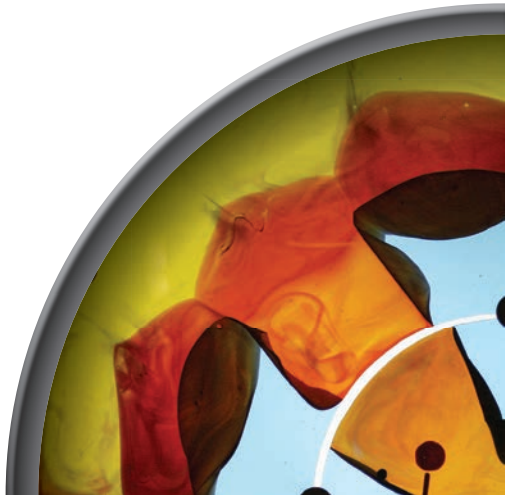
Ardagh North America, Gallo Glass, Owens Illinois Inc., Canada Corp., Rocky Mountain Bottling, and secondary suppliers.

HQ BASED

Arlington, Va., USA.

NOTES

See http://www.gpi.org/advocacy/recycling-energy-policies and http://www.gpi.org/about-gpi/gpi-science-advisory-board.



G-9.) Society for the Advancement of Material and Process Engineering—http://www.sampe.org/

SYNOPSIS

The Society for the Advancement of Material and Process Engineering (SAMPE®) is a global professional member society that provides information on new materials and processing technology via either conferences, exhibitions, technical forums, publications, or books in which professionals in this field can exchange ideas a scientists, engineers, and academicians. SAMPE has professional and student member chapters worldwide. Promoting market diversification, SAMPE disseminates information about the commercial and industrial applications of material and processing engineering. These include land transportation, construction, marine, biomedical and medical, sports and recreation, and industrial applications. Its large subgroups include nationwide organization coverage of North America, Europe, Japan, and China. In its North America subgroup, SAMPE hosts Roadmap Task Forces, one of which is Emerging Technologies. The organization is fairly tightlipped about many activity details, with all detailed documentation tied up in membership exclusive access areas only.

RESEARCH PROGRAMS (IF ANY)

SAMPE was a critical partner with a fiber-glass $1.4M R&D project with the American Composites Manufacturer's Association.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

N/A.

MEMBERSHIP/BUSINESS MODEL

Membership predominantly, but SAMPE also offers conferences and publications.

Professional Membership Rates

	New Member	Renewal
North America - Yearly (Auto Renew)**	$122	$102
North America - Monthly (Auto Renew)**	$9	
China - Yearly	$122.00	
Europe - Yearly	$122.00	
International* - Yearly**	$113.00	
International* - Monthly**	$9	
Japan - Yearly	$122.00	
Mexico - Yearly	$55.00	

* Excludes Europe, Japan, North America, China, and Mexico

**Auto Renew - North American and International memberships renew automatically, based on term (yearly or monthly). When you pay using credit card, the card used will be charged upon renewal.

Student Membership Rate

Europe	$30.00
International*	$20.00

*Includes North America, South America, Africa, Asia, and Australia

MEMBERS

N/A.

HQ BASED

Diamond Bar, Calif., USA.

NOTES

None.

G-10.) American Composites Manufacturers Association—http://www.acmanet.org/

SYNOPSIS

ACMA is partially responsible for America's fiberglass composites manufacturing industry advocacy and is the composites industry's largest trade group in the world. ACMA provides a forum for members of the composites industry to come together to develop shared market opportunities and deal with common challenges. It is recognized as an unmatched source of up-to-date information about the composites industry and the premier provider of educational resources relating to the field. The association offers considerable education programs and conferences to support its many members. Education programs include certifications, such as manufacturing techniques in casting and molding. It also has a bookstore. Members receive many resources, free or discounted access to web-based education, and more. Technical and advocacy subgroups around manufacturing processes or end-use applications get into finer detail with many success stories of outcomes:

- Architectural Division;
- Automotive Composites Alliance;
- Corrosion Control Division;
- Fiberglass Grating Manufacturers Council;
- FRP—Rebar Manufacturers Council;
- Green Composites Council;
- High-Performance Council;
- Pultrusion Industry Council;
- Press Molders Council;
- Transportation Structures Council; and
- Utility and Communications Structures Council.

RESEARCH PROGRAMS (IF ANY)

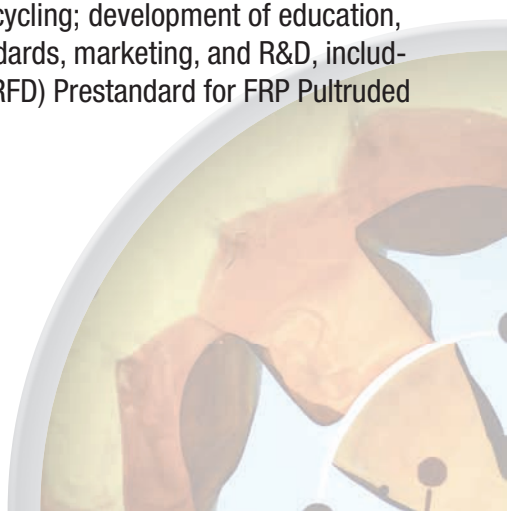
ACMA administered several notable R&D projects for fiberglass and glass-fiber composite materials, including fiber recovery/recycling; development of education, standards, and marketing for the use of C-Glass and quartz high-performance fibers; and pultrusion processing education, standards, marketing, and R&D, including a $1.4M, three-year project with the American Society of Civil Engineers to develop a Load and Resistance Factor Design (LRFD) Prestandard for FRP Pultruded Composites (New Standard Development).

MANUFACTURING DEMO PROGRAMS (IF ANY)

None.

IP POLICIES (IF ANY)

None.



MEMBERSHIP/BUSINESS MODEL

Membership based, broken down into categories accessing various benefits. Other income includes books, classes, and certifications. Some subgroups (councils) require additional fees beyond membership.

Manufacturers

Dues are based on annual sales volume in composites industry

- ☐ Level 01 — under 1 mil $1,012
- ☐ Level 02 — 1-2 mil $1,278
- ☐ Level 03 — 2-5 mil $1,704
- ☐ Level 04 — 5-10 mil $2,663
- ☐ Level 05 — 10-25 mil $5,325
- ☐ Level 06 — 25-50 mil $7,455
- ☐ Level 07 — 50-75 mil $9,585
- ☐ Level 08 — 75-100mil $13,845
- ☐ Level 09 — 100-150 mil $19,170
- ☐ Level 10 — 150-300 mil $24,495
- ☐ Level 11 — over 300 mil $29,820

Suppliers

Dues are based on annual sales volume in the North American composites industry

- ☐ Level 01 — under 1 mil $2,237
- ☐ Level 02 — 1-2 mil $2,929
- ☐ Level 03 — 2-5 mil $3,994
- ☐ Level 04 — 5-10 mil $6,124
- ☐ Level 05 — 10-25 mil $10,118
- ☐ Level 06 — 25-50 mil $12,780
- ☐ Level 07 — 50-75 mil $20,768
- ☐ Level 08 — 75-100mil $26,625
- ☐ Level 09 — 100-150 mil $31,950
- ☐ Level 10 — 150-300 mil $37,275
- ☐ Level 11 — over 300 mil $42,068

Distributors

Dues are based on annual sales volume in the North American composites industry

- ☐ Level 01 — under 1 mil $2,130
- ☐ Level 02 — 1-2 mil $2,663
- ☐ Level 03 — 2-5 mil $3,195
- ☐ Level 04 — 5-10 mil $4,260
- ☐ Level 05 — 10-25 mil $6,124
- ☐ Level 06 — 25-50 mil $8,520
- ☐ Level 07 — 50-75 mil $11,183
- ☐ Level 08 — 75-100mil $15,975
- ☐ Level 09 — 100-150 mil $21,300
- ☐ Level 10 — 150-300 mil $27,690
- ☐ Level 11 — over 300 mil $34,080

Affiliates

Dues are based on the type of Affiliate membership

- ☐ Academic $250
- ☐ Consultant (sole proprietorship) $550
- ☐ Regional Association $250
- ☐ National Association $550
- ☐ Press $1,000
- ☐ End User, Designer, Specifier $2,500

MEMBERS

Major corporate members include BASF, Dow, and Ferro.

HQ BASED

Arlington, Va., USA.

NOTES

Complte membership list at http://www.acmanet.org/images/Membership/Member-List/Membership-FY2016-2017-as-of-Jan2017.pdf; http://www.acmanet.org/images/CGI_Initiative.pdf. All available education components at http://www.acmaeducationhub.org/home (under Catalog).

G-11.) American Glass Research—http://www.americanglassresearch.com/industry/glass-manufacturers

SYNOPSIS

Although research appears in the title of this organization, AGR is a for-profit, independent laboratory that works almost exclusively with industry, yet also develops unique training courses for the glass industry. The majority of its testing and analytical services is for glass packaging. However, it also serves the flat-glass, automotive-glass, specialty-glass, and even the ceramic/whitewares markets. Furthermore, the company focuses on the pharmaceutical market, which appears to be rare. Its training programs are very focused on industry and even provide private/in-plant training for custom workforce development. Although much of its training is on highly technical, manufacturing topics (http://www.americanglassresearch.com/training/seminar-catalogue), it has a wide-appealing training program for audits and even an auditor course for glass-plant container operations. AGR offers these courses worldwide. Finally, the company hosts a library of testing/analytical, additives, and other material-centric specific publications, all free for public consumption.

RESEARCH PROGRAMS (IF ANY)

N/A.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

N/A.

MEMBERSHIP/BUSINESS MODEL

This is a for-profit company. Therefore, fees are paid for services rendered and training courses.

MEMBERS

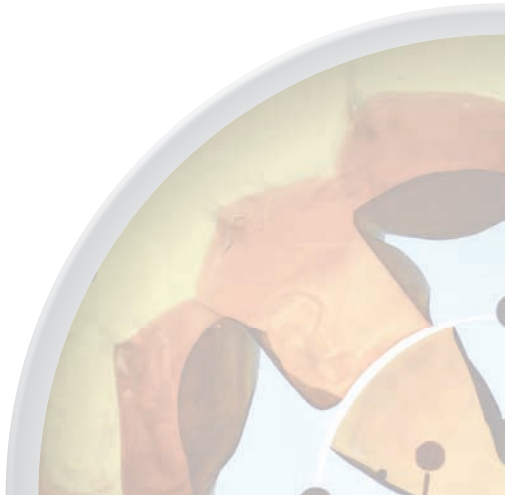
N/A.

HQ BASED

Butler, Pa., USA.

NOTES

None.



G-12.) European Container Glass Federation—http://feve.org/

SYNOPSIS

FEVE is the Federation of European manufacturers of glass containers and machine-made glass tableware. Its members produce more than 20 million tonnes of glass per year. The association includes about 60 corporate members belonging to approximately 20 independent corporate groups. Manufacturing plants are located across 23 European countries and include global blue-chip and major companies working for the world's biggest consumer brands. The group predominantly hosts advocacy in Europe and has several publications. It also hosts "Friends of Glass," which asks consumers to promote glass packaging as an environmentally safer packaging alternative. The organization and website act as a clearinghouse of information for all glass-packaging-related topics.

RESEARCH PROGRAMS (IF ANY)

N/A.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

N/A.

MEMBERSHIP/BUSINESS MODEL

HEVE appears to be an advocacy group with no formal membership/dues.

MEMBERS

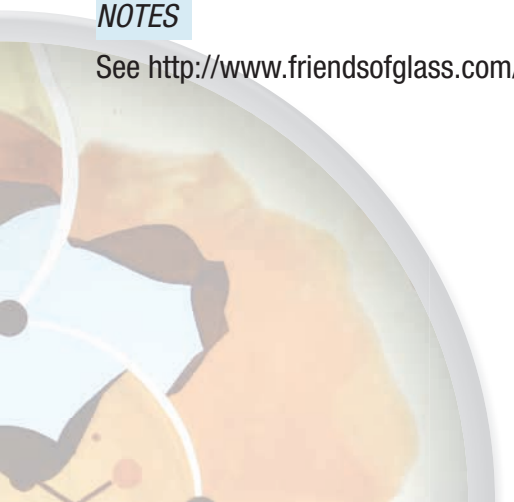
Notable members include Ardaugh, Vetropack, Owens-Illinois, Saverglass, Verallia. All members list at http://feve.org/about-feve/feve-members/.

HQ BASED

Brussels, Belgium.

NOTES

See http://www.friendsofglass.com/.



G-13.) British Glass—http://www.britglass.org.uk/

SYNOPSIS

British Glass Manufacturers Confederation is instrumental in promoting glass as first-choice material across all glass sectors and ensuring that the industry and its products remain competitive, innovative, and are not unnecessarily or disproportionately hindered by new regulation, standards, or legislative changes. British Glass acts as the industry's focal point, playing the principal role in communicating the concerns and aspirations of its members to the government, the European Union, and other external interest groups and trade bodies. British Glass has a world-renowned reputation for representing the glass container industry in standards through BSI (British Standards Institute), CETIE (International Technical Centre for Bottling and Packaging), CEN (European Standards Body), and ISO (International Standards Organization). Besides a robust technical program, the organization hosts publications and a glass industry awards program.

RESEARCH PROGRAMS (IF ANY)

It appears sometimes, although not recently, British Glass offers R&D funding grants. Also, the organization stimulates innovation, R&D, and further development of the material glass, associated technologies, uses, and applications. This is accomplished partially through its traditional working groups and stakeholder engagement, but also more proactively by facilitating discussion on specific threats or opportunities identified by the industry, its supply chain, or competitors. To do this, the group has an independent, technology-consulting firm that acts as a center of excellence, which conducts everything from research to testing. Named GTS, the organization has extensive R&D assets, including pilot melting capabilities. See http://www.glass-ts.com/research-innovation-development and http://www.glass-ts.com/technical-consultancy.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

N/A. Because the organization hosts an independent technology consulting group, that group has separate projects/policies. It is involved with outside consortiums, but that is outside the scope of British Glass.

MEMBERSHIP/BUSINESS MODEL

Membership model, but not available to the public. Income also is available from for-profit technology arm.

MEMBERS

Ardaugh, Beatson Clark, Consol, D Swarovski & Co., Diageo, Guardian, Owens-Illinois, Pilkington, Plowden & Thompson, Potters, Rio Tinto, Saint-Gobain, and Siemens.

HQ BASED

South Yorkshire, United Kingdom.

NOTES

Technical effort presentations at http://www.britglass.org.uk/technical and actual projects of R&D nature at http://www.glass-ts.com/projects.

G-14.) The Fiber Optic Association Inc.—http://www.thefoa.org/

SYNOPSIS

FOA is chartered to promote fiber optics through education, certification, and standards. FOA has certified about 60,000 CFOTs (Certified Fiber Optic Technicians) through more than 250 approved training organizations in 40 countries worldwide. FOA certifications are recognized by the U.S. Department of Labor. Besides training, the organization is a large clearinghouse of information on fiber optics, especially fiber-optic product catalogs. This appears to be a very small organization with grassroots efforts and very little glass material related.

RESEARCH PROGRAMS (IF ANY)

N/A.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

N/A.

MEMBERSHIP/BUSINESS MODEL

Membership dues for current members who are certified: 1 year, $50; 2 years, $80, and 3 years, $100.

MEMBERS

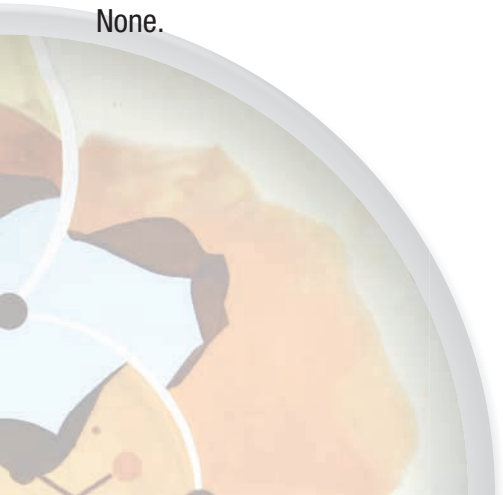
Notable members include Taihan Fiberoptics. Complete list of members at http://foa-approved.org/corporate_members.

HQ BASED

Fallbrook, Ca., USA.

NOTES

None.



G-15.) The Optical Society—http://www.osa.org/

Relevance to Roadmap Objectives is 80%..

SYNOPSIS

Founded in 1916, The Optical Society (OSA) is the leading professional association in optics and photonics and is home to accomplished science, engineering, and business leaders worldwide. This large association covers education, conferences, and publications around all topics related to optics. Particular glass technology topics include fiber optics, glass waveguides, lens, and mirrors, which often appear in publications and some conferences.

RESEARCH PROGRAMS (IF ANY)

N/A. OSA seems to host no R&D projects, but does support R&D activities through publications, conferences, and access to technical groups. See http://www.osa.org/en-us/corporate_gateway/industry_membership/benefits/#rd.
The association also hosts "incubators" – a fresh collaborative approach to letting like-minded researchers and other interested parties meet on technical topics. See http://www.osa.org/en-us/meetings/incubator_meetings/.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

N/A. Because it does not host R&D projects, there seems to be no IP policy..

MEMBERSHIP/BUSINESS MODEL

Tiered membership by organization types. Industry memberships are highest echelon.

2016 OIDA Member Dues

OIDA Member Type: Annual Sales Volume	Dues
Tier 1:Less than $2 Million	Contact OSA
Tier 2: $2-$10 Million	$950
Tier 3: $10-$20 Million	$1,900
Tier 4: $20-$50 Million	$3,500
Tier 5: $50-$100 Million	$6,500
Tier 6: $100-$500 Million	$9,500
Tier 7: $500 Million-$1 Billion	$11,500
Tier 8: Over $1 Billion	$16,500
Special Rates	
University/Cluster	$1,500
Recruiter/Non Profit	$750

OIDA Member Type	Number of Free Individual OSA Memberships for Company Employees
Tier 1: Less than $2 Million	3
Tier 2: $2-$10 Million	3
Tier 3: $10-$20 Million	7
Tier 4: $20-$50 Million	10
Tier 5: $50-$100 Million	20
Tier 6: $100-$500 Million	20
Tier 7: $500 Million-$1 Billion	20
Tier 8: Over $1 Billion	20
Special Rates: University/Cluster	3
Special Rates: Recruiter/Non Profit	3

MEMBERS

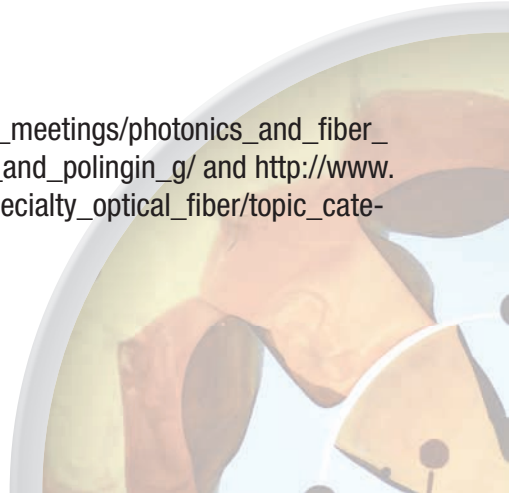
Chiral Photonics, Inrad Optics, IRflex Corp., LightPath Technologies, and SCHOTT. See http://www.osa.org/en-us/osa_directories/organization_directory/.

HQ BASED

Washington, D.C., USA.

NOTES

See http://www.osa.org/en-us/meetings/osa_meetings/photonics_and_fiber_technology/bragg_gratings_photosensitivity_and_polingin_g/ and http://www.osa.org/en-us/meetings/topical_meetings/specialty_optical_fiber/topic_categories/.



G-16.) American Precision Optics Manufacturing Association—http://www.apoma.org/

SYNOPSIS

APOMA members represent the operational and front-line leaders in American optical fabrication. The organization offers a way for peers to cooperate and share best practices. The organization hosts meetings and publications to tackle topics of optical standards, fabrication, training, and education in these areas. It partners often with SPIE and OSA, but offers breakout groups particular to precision optics within these larger associations and their annual conferences.

RESEARCH PROGRAMS (IF ANY)

APOMA seem to collaborate on SPIE's larger offerings/programs and in its technical workshops, but no formal R&D programs or projects..

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

N/A.

MEMBERSHIP/BUSINESS MODEL

Membership. Corporate Annual Dues by Company Size: 1–15 employees, $300; 16–60 employees, $450; 61–125 employees, $700; >125 employees, $1,300; Associate $350, Affiliate $1200; and Academic, free.

MEMBERS

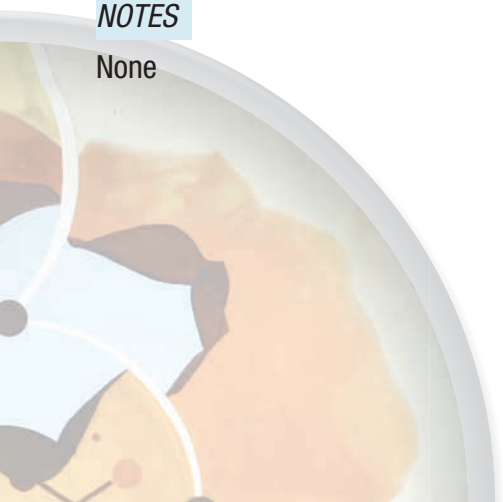
Notable members include A.M.F. Optics, Edmund Optics, Gooch and Housego, CDGM Glass, JENOPTIK, Corning, Davidson Optronics, Dynasil, and PFG Precision Optics. Full member list at http://www.apoma.org/member-list/.

HQ BASED

Rochester, N.Y., USA.

NOTES

None



G-17.) GlassFibreEurope (APFE—European Glass Fibre Producers Association)—http://www.glassfibreeurope.eu/

SYNOPSIS

GlassFibreEurope is a member of Glass Alliance Europe (formerly CPIV) and has developed close partnerships with other associations that represent glass sectors, e.g., FEVE, the Europe Container Glass Industry Association; Glass for Europe, the European Flat Glass Industry Association; EDG, the European Domestic Glass Committee; ICF, International Crystal Federation; and ESGA, European Special Glass Association. Other association affiliations relate to up- and down-stream users, including CEFIC (Conseil Européen de l'Industrie Chimique), PlasticsEurope, and the European Composites Industry Association. GlassFibreEurope includes producers of reinforcement fibers and glass yarn only. Producers of glass wool are affiliated with EURIMA, the European Insulation Manufacturers Association. GlassFibreEurope member companies located in the EU-28 and Turkey make a significant contribution to the welfare of the citizens by enabling innovation, creating quality of life, and facilitating resource and energy efficiency as well as climate protection. About 5,000 people are employed by GlassFibreEurope member companies in the EU-28. GlassFibreEurope members manufacture "continuous filament glass fiber" products. The continuous filament glass fiber production process differs drastically from the production process and use of insulation glass fibers. The insulation glass fiber is generally termed "glass wool." The group mostly commits advocacy for European-produced products against Chinese and other exporters.

RESEARCH PROGRAMS (IF ANY)

The group claims to conduct detached expert studies and sharing of best practices, although no thorough details are found except in the projects outlined in the News section, see http://www.glassfibreeurope.eu/.

MANUFACTURING DEMO PROGRAMS (IF ANY)

N/A.

IP POLICIES (IF ANY)

N/A.

MEMBERSHIP/BUSINESS MODEL

Membership dues and exact business model not found.

MEMBERS

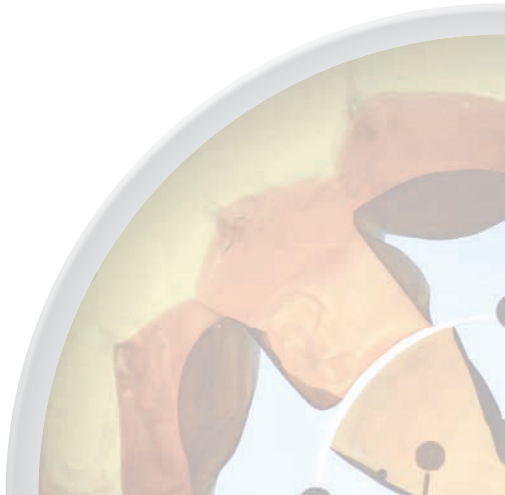
Johns Manville, CamElyaf, LanXess, Owens Corning, PPG Fiber Glass, Vetrotex, and 3B.

HQ BASED

Brussels, Belgium.

NOTES

None



RESEARCH AND DEVELOPMENT SPECIFIC GLASS ORGANIZATIONS/INITIATIVES

R-1.) Usable Glass Strength Coalition (UGSC)— http://gmic.org/ugsc/

SYNOPSIS

UGSC is an industry-driven and supported precompetitive research program to identify critical parameters for improving the usable strength of glass. The Coalition research agenda is comprised of a series of individual, precompetitive multiyear university research projects. Industry and university experts contribute to the creation of a research strategy, guiding a potential research request for proposal that is appended to this document. The research strategy and subsequent RFP is refined through research council and board processes. Precompetitive research focuses include

- A fundamental understanding of the initiation of flaws in simple and multicomponent oxide glasses, including new tools and analysis techniques;
- Ensuring glass science research continues at the university level and to provide industry guidance on the direction of research;
- Fostering collaborative relationships among industry members and between industry and universities;
- Developing the next generation of glass technical experts and researchers;
- Glass surface structure and chemistry, particularly as it relates to the susceptibility to chemical, thermal, and physical damage;
- Mechanisms of chemical and physical damage (flaw generation) as they relate to usable strength reduction; and
- Additional topic areas of interest, such as computer-modeling techniques and surface treatments/coatings.

IP POLICY

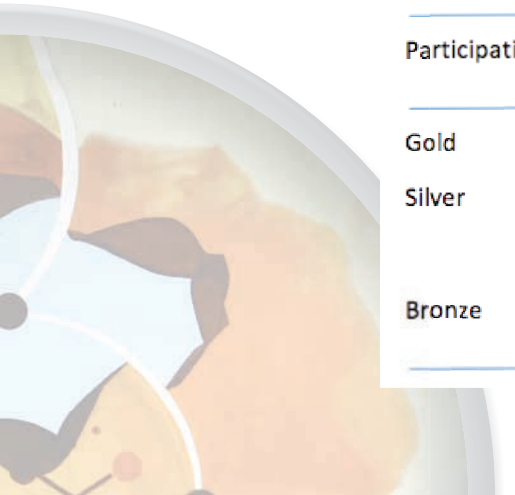
The Coalition places all research results in the public domain and does not seek patent protection. However, Coalition participants have the benefit of having first access to the research results prior to the results being made public.

BUSINESS/MEMBERSHIP MODEL

Business/Membership Model

Membership dues in semiannual payments

Participation level	Sales/buy metric	Annual fee	Voting power
Gold	≥$1B	$40,000	4 votes
Silver	<$1B	$20,000	2 votes
	≥$100M	$20,000	2 votes
Bronze	<$100M	$10,000	1 vote



MEMBERS

International welcome. Diageo, User, Silver Level; Johns Manville, Manufacturer, Gold Level; PepsiCo, User, Silver Level; Sun Chemical, Supplier, Bronze Level; U.S. Borax/Rio Tinto Minerals, Supplier, Bronze Level; and GMIC, Trade Association, Sponsor.

NOTES/SPECIFICS

Westerville, Ohio, USA.

NOTES

October 2016—UGSC announces award of $80,000 for a grant to Colorado School of Mines (Golden, Colo.). The research title is Fundamental Understanding of Strength-Limiting Flaws in Multicomponent Glass. A flaw that dictates fracture in glass may have many attributes that are not included in a standard fracture mechanics approach to predict failure. This is particularly true for high-strength glasses where flaw nucleation is at the atomic or nanometer scale or depends on processes at the atomic or nanolength scale. The research seeks to understand the nature of these flaws in relation to the nucleation of cracks and their formation during processing or handling in specific situations, such as in the container and fiber industries. A combination of fracture testing, nanoscale characterization, and modeling are used to describe how cracks nucleate. Modern analytic instrumentation, including focused ion-beam (FIB) sectioning, atom probe tomography (APT), and state-of-the-art electron microscopy are used to enable previously unachievable levels of resolution and analytical information.

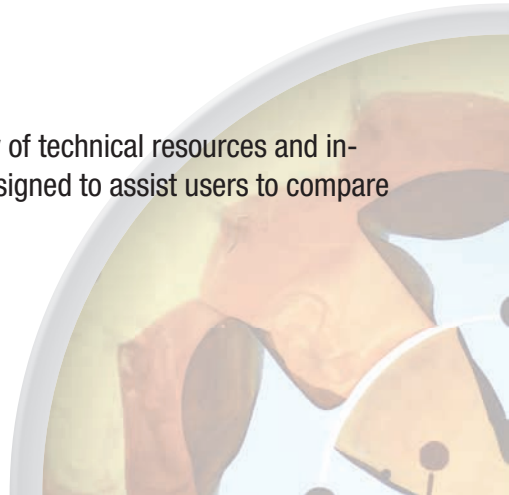
October 2016—UGSC announces that a Pennsylvania State University (University Park, Pa.) research grant is renewed for the fourth year.

October 2, 2013—UGSC announces an award of $110,000 for a grant to Pennsylvania State University to conduct research to improve the understanding of manufactured glass products' strength properties (currently renewed for fourth year). The study characterizes the distribution and chemical nature of reactive surface sites on glass that nucleate strength-controlling defects. The research abstract states, "It is reasonable to expect that the existence and concentration of strength-controlling atomic and nanoscale defect precursors depend on the surface cooling rate and the local atmosphere. These processing variables could provide an effective means to controlling and enhancing the strength of glass through irreversible chemical (or physical) passivation of these defect precursors at time of their creation."

R-2.) Lawrence Berkeley National Laboratory-Windows & Daylighting Group—http://windows.lbl.gov

SYNOPSIS

Lawrence Berkeley is a leading window research facility sponsored by U.S. Department of Energy. Its site provides a wide variety of technical resources and information about obtaining its widely used software programs, Windows 4.1 (used for NFRC program) and RESFEN (a program designed to assist users to compare how various window types affect the energy requirements of a home).



R-3.) Society of Glass Technology—http://www.sgt.org/SGT/AbouttheSGT.html

SYNOPSIS

The Society of Glass Technology exists to serve people who are interested in the production, properties, or uses of glasses, whether from a commercial, aesthetic, academic, or technical viewpoint. It is a U.K.-based nonprofit organization serving a worldwide membership publishing journals and text books; organizing meetings, symposia, and conferences on glass related topics; coordinating the activities of special interest groups and technical committees; and providing a communication framework geared to the needs of the glass community. There is a North American section. Members have access to conferences, publications, library, and some certifications. Supposedly, technical committees meet with industry members to discuss the following topics:

- Basic science and technology;
- Analysis and properties; and
- Melting technology and refractories.

Special interest groups in glasses for optoelectronics and glass information also exist.

BUSINESS/MEMBERSHIP MODEL

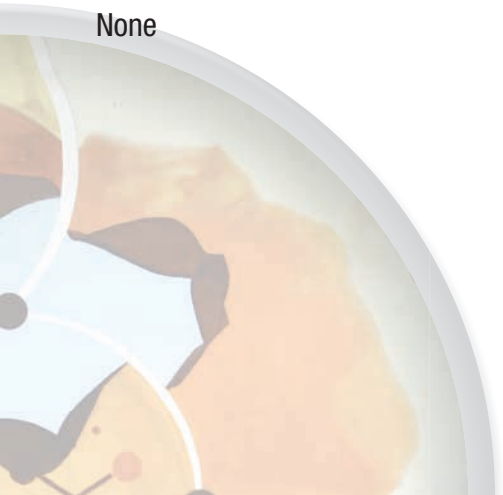
Complete spectrum of dues-paying participants from student to corporate. Corporate rates, differentiated by journal publication subscriptions, are C1 Corporate Membership Rates, £276.50; and C2 Corporate Membership Rates, £530.00.

MEMBERS

N/A.

NOTES/SPECIFICS

None



R-4.) Glass Technology Research and New Developments (GlassTrend)—http://www.glasstrend.nl/about-GlassTrend.php

SYNOPSIS

CelSian Glass and Solar (Eindhonem, the Netherlands) facilitates GlassTrend (Glass Technology Research and New Developments), an international open platform for precompetitive, cost-sharing research projects. GlassTrend has a managing board and advisory board consisting of industry members and CelSian representatives. At biannual council meetings, multicustomer R&D projects are defined and executed addressing priority market needs. Topics of interest include glassmelting and furnace technology, application, and glass processing. In addition to state-of-the-art glass technologies, disciplines and technologies of various industrial domains are combined to generate innovative solutions or new valuable knowledge incorporating such topics as energy reduction, new measurement technologies, emissions, refractories, corrosion, and advanced process control. In addition to R&D efforts, GlassTrend also hosts annual events, seminars, two-day workshops, and training courses on a budget of €180,000/year.

IP POLICY

All GlassTrend members are given the opportunity to join R&D projects on a cost-sharing basis. The results are shared within those participating companies

MEMBERS

3B Fibre Glass
Air Liquide
Allied Glass Containers Ltd.
Alteo
American Glass Research
Asahi Glass Corp.
ARC International
Ardagh Group
BDF Industries
Celsian Glass & Solar
Corning Incorporated
Ducatt
Eurotherm/Schneider Electric
Fives Stein
Glass Service
Glass Service S.r.l.
Guardian Flat Glass Central
Gulf Glass Manufacturing Co.
Harbison Walker International
HVG-DGG
Johns Manville
Johnson Matthey
Knauf Insulation
Land Instruments Intl Ltd.
Lanxess
Libbey Glass
Linde AG
Nadir Figureido
NEG
Owens-Illinois
Owens Corning
PFG Building Glass
Philips Lighting
PPG
Praxair
Quarzwerke
RHI Refractories
Rio Tinto
RWTH
Saint Gobain
Schott AG
SGD
Sibelco
Sisecam
Stazione Sperimental del Vetro
Verallia
Vetropack
Vidrala
Vitro

NOTES/SPECIFICS

Current and completed research projects since inception in 2001:

2015 to present—Foam sensor for the glass industry (five partners);

2014 to present—Corrosion resistance of condensation zone regenerator refractories at low-NOx combustion conditions for soda-lime-silica glass-producing furnaces (five partners);

2008 to present—Batch pelletizing and pellet preheating by glass furnace flue gases (eight partners);

2014 to 2015—Measures to destabilize foam in industrial glass furnaces producing borosilicate glasses (four partners);

2012 to 2013—Experimental investigations on fining behavior and transmission of ultraclear soda-lime-silica glasses (10 partners);

2012 to 2013—Control of batch chemistry and melting technology for amber component glasses (five partners);

2010 to 2012—Energy balance modeling for glass furnaces (eight partners);

2007 to 2008—Sulfur chemistry in alkali-free/alkali-lean glasses (four partners);

2006 to 2009—Low-NOx regenerative glass furnace (nine partners);

2005 to 2010—Control of SO2 emissions and foaming, and improvment of sulfate fining in soda-lime-silica glasses (seven partners);

2005 to 2008—Reduction of silica crown attack by glass furnace atmospheres (eight partners);

2003 to 2008—Feasibility of LIBS for analyses in the glass industry (four partners); and

2002 to 2007—Modeling of evaporation processes in glass furnaces (five partners).

R-5.) Centre for Functional and Surface-Functionalized Glasses (FunGLASS)—http://funglass.eu/

SYNOPSIS

Five European research institutions made up a new cutting-edge functional glass research center. This was a one-year (June 2015 through May 2016) EUR 310 332,25 project to develop a financial and business plan for upgrading the existing Centre of Excellence for Ceramics, Glass, and Silicate Materials (Bratislava, Slovakia) to an international research hub for functional glass. Full development of the consortium is subject to further funding by the EU or other sources. The research institution partners include Centre of Excellence for Ceramics, Glass, and Silicate Materials, University of Trenčín (ADU, Trenčín, Slovakia); Institute of Biomaterials, Friedrich-Alexander University Erlangen-Nürnberg (FAU, Erlangen, Germany); Otto Schott Institute of Materials Research, Friedrich Schiller University Jena (FSU, Jena, Germany); Institute for Ceramic and Glass, Spanish National Research Council (CSIC, Madrid, Spain); and Department of Industrial Engineering, University of Padova (UNIPD, Padova, Italy). The envisioned research program is to include cutting-edge research of glass with special functional properties (luminescence, electric, magnetic, catalytic, and sorption) and new/modified surface functionalized conventional glasses. Specific topics include the following.

• Development of materials and technologies for more efficient energy harvesting, especially solar, more efficient energy use through development of materials for energy-efficient lighting applications, and surface modification of building materials, such as construction glass panels with increased energy efficiency. Research topics include Smart Cities and Communities, Competitive Low-Carbon Energy, and Energy Efficiency in the fields related to secure clean and efficient energy.

• Personalized health and care, including development of new types of glass-based biomaterials, tailoring their properties through, e.g., surface modification and development of technologies for adjusting their performance to particular needs of individual patients.

• A resource to recycle, reuse, and recover raw materials, including development of new materials based on glass waste (glass is, in principle, 100% recyclable)

and development and introduction of new technologies for utilization of industrial and household waste for production of glass and glass-ceramic materials.

The new Centre expects to recruit high-quality researchers worldwide and plans to offer a graduate program to award joint diplomas among the participating universities.

BUSINESS/MEMBERSHIP MODEL

The model remains under development. Marketing documents suggest achievement of financial self-sufficiency by 2026. It appears initial infrastructure funding will be applied under the EU Horizon 2020 program and the Slovak government. See http://funglass.eu/media/sitemedia/2016-04_Funglass_ICG-Shanghai.pdf.

IP POLICY

Under development.

NOTES/SPECIFICS

Final report submitted to EU on the one-year project. See http://cordis.europa.eu/result/rcn/190394_en.html.

R-6.) International Materials Institute for New Functionality in Glass (IMI-NFG)—http://www.lehigh.edu/imi/

SYNOPSIS

A research and education center operated by Lehigh University (Bethlehem, Pa.) and Pennsylvania State University (University Park, Pa.) funded by NSF from August 2004 through August 2015. The advisory boards included U.S.-based and international university researchers and members from international glass companies, such as Corning, PPG, Saint Gobain, and Schott. Primary research areas included active glass, biomedical glass, low-Tg glass, and strength in glass. There also was a significant focus on glass education from undergraduates to postdoctorals and a publicly available teaching/training repository of courses.

BUSINESS/MEMBERSHIP MODEL

Funded by NSF in two five-year grants.

BUSINESS/MEMBERSHIP MODEL

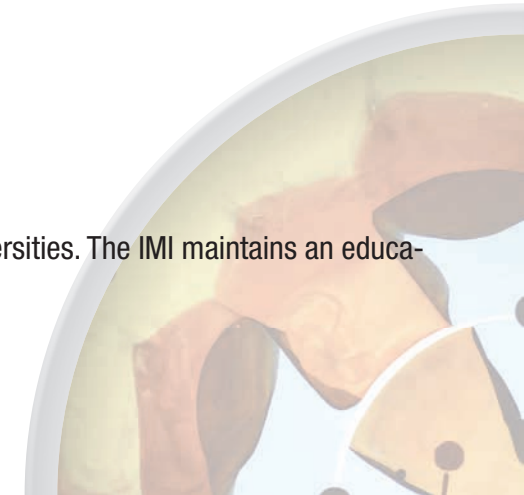
Corning, PPG, Saint Gobain, and Schott.

IP POLICY

Strictly research based.

NOTES/SPECIFICS

NSF funding ended for the IMI-NFG in August 2015. Professors involved in leading the institute remain at their respective universities. The IMI maintains an educational resource online, but is not hosting REU students at this time.



R-7.) Center for Research, Technology, and Education in Vitreous Materials (CeRTEV)—http://www.certev.ufscar.br/slideshow

SYNOPSIS

CerTEV is a glass research center funded in 2013 by The São Paulo State Research Foundation (São Paulo, Brazil) consisting of 14 researchers, 2 educators, and 50 students across 3 universities. Core research focuses on strong GCs for armors and dental implants, bioactive materials for bone and tissue restoration, energy storage and conversion systems, photonic devices, and catalysts for converting biomass to fuels and chemicals. There is a strong educational component to the program highlighting the need to educate and train new glass research experts.

BUSINESS/MEMBERSHIP MODEL

The Center is funded by The São Paulo State Research Foundation (FAPESP) for five years at $2M per year, with the option to renew for an additional six years. Research internships are paid jointly by CerTEV and the industry collaborator. Separate agreements for specific research projects are developed between CerTEV and partnering companies.

MEMBERS

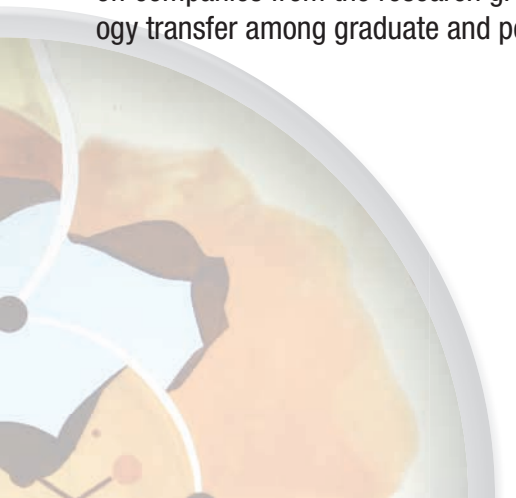
The Center does not publish a member list, only details on specific collaborations.

NOTES/SPECIFICS

Specific research projects with partnering companies include Nippon Sheet Glass, Japan, Dynamic processes in undercooled glass-forming liquids; OptiGrate, USA, Improvement of photothermo refractive glasses; AGY, USA, Development of special fibers; Saxon Glass, USA, Chemical strengthening of glass; Infibra, Brazil, Development of alkali-resistant glass fibers for cement reinforcement; VitroVita, Brazil, Development of bioactive glasses and glass-ceramics; and Nippon Sheet Glass, Japan, Glass sintering.

IP POLICY

Three methods of technology transfer are used: collaborative agreements and licenses of on-demand technologies commissioned by industry; nucleation of spin-off companies from the research group activities (funding to be pursued through various government entities); and extensive promotion of innovation and technology transfer among graduate and postdoctoral students through fellowships and internships with industrial partners.



R-8.) Central Glass and Ceramic Research Institute (CGCRI)—www.cgcri.res.inw

SYNOPSIS

CGCRI is a national research organization in India under the council of Scientific and Industrial Research. The major clients are primarily the Indian government and manufacturers in India requiring glass and ceramics research expertise.

Glass research topics include

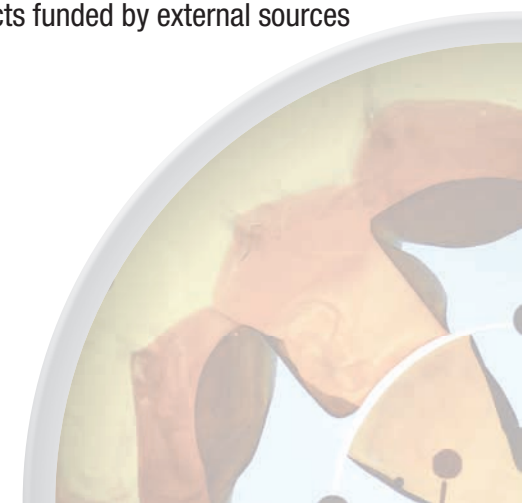
- Various specialty glasses and glass-ceramics for advanced technology applications;
- Lead-free environment-friendly glass powders and pastes for plasma display panel (PDP);
- Rare-earth-doped nanocrystalline nonlinear optical glass-ceramics;
- Glass and glass-ceramics for photonics and solar cell applications;
- Nanometal glass nanocomposites;
- Low-melting transparent sealing glass;
- Rare-earth-associated nanocrystals in glasses for solar concentrators and infrared sensors;
- Synthesis of CNT dispersed inorganic composites for transparent conducting media;
- Glass-ceramics for armor application;
- Chalcogenide glasses for infrared optic and photonic devices;
- Rare-earth-doped glasses for fluorescence cooling; and
- Energy-efficient method for preparation of glass by microwave heating.

IP POLICY

The goal of CGCRI is development and transfer of technology capable of translating knowledge to viable technology. In all projects funded by external sources (agency, industry, institution, etc.), CGCRI utlitizes a nondisclosure agreement model to protect client information.

BUSINESS/MEMBERSHIP MODEL

CGCRI conducts sponsored, grant-in-aid, consultancy, or in-house projects.



R-9.) International Partners in Glass Research (IPGR)—https://www.ipgr.com/ipgr-about-us/philosophy.html

SYNOPSIS

IPGR primarily focuses on glass container precompetitive research topics, such as increasing glass strength, precise control of manufacturing processes through simulation and benchmarking, and optimizing forming. Additional research aims are improving energy efficiency in glassmelting and reducing emissions. The executive committee is formed with a decision maker from each member company, meeting once per year to decide roadmaps for IPGR. A general manager is responsible for R&D projects and administration, and technical committees are formed of experts from member companies.

MEMBERS

Bucher Emhart Glass
Fevisa
Gallo Glass Co.
Nihon Yamamura Glass
Orora Ltd.
Şişecam (Glass Packaging Division)
Vetropack Vidrala Group
Wiegand-Glas

R-10.) New Glass Forum—http://www.newglass.jp/c2e.shtml

SYNOPSIS

New Glass Forum is a nonprofit Japanese organization existing to encourage high-technology glass industries through information exchange between industry and academia and to improve standards of living and prosperity through glass. It maintains an international glass database called Interglad and participates in R&D, training, industrial standards, etc.

BUSINESS/MEMBERSHIP MODEL

Full-member initial entrance fee is 100 thousand yen; membership fee is at least 400 thousand yen per year. Associate member initial entrance fee is 100 thousand yen; membership fee is at least 200 thousand yen per year.

MEMBERS

Corporate members (25)

Asahi Glass Co. Ltd.
AGC Techno Glass Corp.
Ishizuka Glass Co. Ltd.
Okamoto Glass Co. Ltd.
Ohara Inc.
Ohara Quartz Co. Ltd.
Olympus Corp.
Canon Inc.
Corning International Co. Ltd.
Covalent Materials Co. Ltd.
Schott Nippon Co. Ltd.
Sumita Optical Glass Inc.
Sumitomo Electric Ind. Ltd.
Central Glass Co. Ltd.
Toyo Glass Co. Ltd.
Nikon Corp.
Nippon Sheet Glass Co. Ltd.
The Glass Manufacturers' Association of Japan
Nihon Taisanbin Glass Bottle Mfg. Co. Ltd.
Nippon Electric Glass Co. Ltd
Nihon Yamamura Glass Co. Ltd.
P.J.L Ltd.
Fujikura Ltd.
HOYA Corp.
Maeda Glass Co. Ltd.

Associate members (25)

Atock Co. Ltd.
AvanStrate Inc.
Asahi Fiber Glass Co. Ltd.
Isuzu Glass Co. Ltd.
AGC Research Institute Inc.
Denso Wave Inc.
Kidokoro Chemical Co. Ltd.
Koa Glass Co. Ltd.
Konica Minolta Opto Inc.
Konishiyasu Co. Ltd.
Cohehrent Japan Inc.
SUMCO Corp.
Soga Glass Co. Ltd.
Tosoh Corp.
Hikari Glass Co. Ltd.
Fujinon Corp.
Furuya Metal Co. Ltd.
Hamamatsu Photonics Co. Ltd.
Hitachi Ltd.
Mitsuboshi Diamond Industrial Co. Ltd.
Mizuho Information and Research Institute Inc.
NEC Corp.
U-VIX Corp.
Senyoh Glass Ind. Co. Ltd.
Toho Gas Co. Ltd.

Respective Members

Researchers and engineers from universities and national institutes (47).

R-11.) Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) Advanced Manufacturing Office (AMO)—https://energy.gov/eere/amo/glass

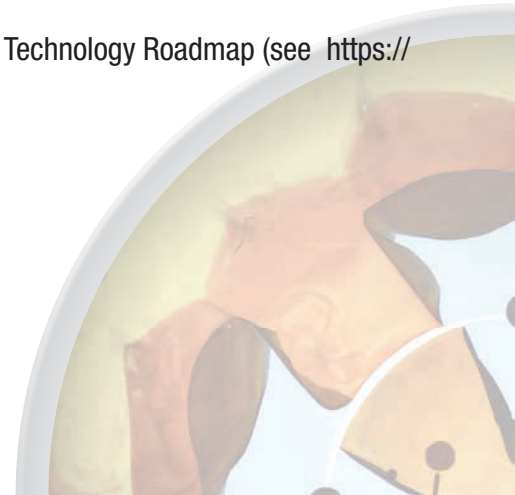
SYNOPSIS

The Advanced Manufacturing Office in the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy invests in a wide range of research projects, including innovative process and materials technologies and next-generation manufacturing processes and materials. Glass and glass products are one area of interest.

NOTES/SPECIFICS

Two AMO-funded technology development projects with private companies are (2002) High-Luminosity, Low-NOx Burner Performed by Eclipse and (2006) Process for Converting Waste Glass Fiber into Value-Added Products performed by Abacem. Analytical studies and publications include (2010) Manufacturing Energy and Carbon Footprints—Glass (see https://energy.gov/sites/prod/files/2014/02/f7/2014_glass_energy_carbon_footprint.pdf);

(2007) Industrial Glass Bandwidth Analysis; (2002) Energy and Environmental Profile of the Glass Industry; (2002) Glass Industry Technology Roadmap (see https://energy.gov/sites/prod/files/2013/11/f4/glass2002roadmap.pdf); and (1996) Glass Vision.



R-12.) Applied Research Center (ARC)—http://www.discoverarc.com/research/ceramics/

SYNOPSIS

The Advanced Ceramics and Glass Laboratory at ARC focuses on specialty materials used in a variety of ways. The current emphasis is on porous-wall, hollow glass microspheres for biomedical applications. The research laboratory supports collaborations with Virginia Polytechnic Institute and State University (Blckburg, Va.), South Dakota School of Mines and Technology (Rapid City, S.D.), Augusta University (Augusta, Ga.), and Savannah River National Laboratory (Aiken, S.C.). Research/laboratory equipment is reserved by approved parties.

R-13.) Fraunhofer Institute for Surface Engineering and Thin Films—https://www.ist.fraunhofer.de/en/the_institute.html

SYNOPSIS

This German research institute is primarily concerned with applications in thin films and functional coating/coating processes across a wide range of applications, including optics, architectural glass, solar cells, and displays. Chemical vapor deposition, atomic layer deposition, electrochemical processes, and plasma processes are the primary technologies used.

R-14.) German Glass Society (HVG-DGG)—http://www.hvg-dgg.de/en/home.html

SYNOPSIS

Hüttentechnische Vereinigung der Deutschen Glasindustrie e.V. (HVG) is the research association of the German Glass Industry to further develop the scientific knowledge of glass and put the findings in industrial practice. It has approximately 45 members and 50 affiliated plants. It works in partnership with Deutsche Glastechnische Gesellschaft e. V. (DGG), a society open to all members of the glass community with an interest in the physics, chemistry, or technology as well as art and history of glass.

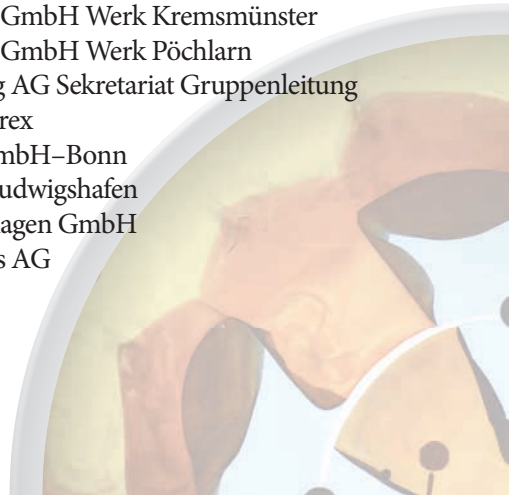
BUSINESS/MEMBERSHIP MODEL

Precompetitive research is funded by annual member contributions and €550,000/year from the Federal Ministry for Economic Affairs. It also offers consultancy services for glassmelting processes and environmental aspects of glass production. Annual fees for DGG Personal Membership are Members, €75.00; Members (pensioners), €38.00; and Members (students), €20.00. A deduction of 25% on this category of DGG membership fee is granted for those persons who also are members of one of the following associations: DECHEMA, DGM, DKG, DPG, DGCh, VDE, VDEh, VDI. Annual fees for Corporate Members are institutes, universities, colleges, associations, and authorities, €75.00; and companies, 1/100% of the turnover made with the glass industry in the previous year, and at least €400.00.

MEMBERS

There are many universities with some ceramics/glass-based laboratories and several with graduate-level curriculums in Engineering or Science Colleges/ Departments.

Ardagh Glass GmbH
Ardagh Glass GmbH Werk Bad Münder
Ardagh Glass GmbH Werk Drebkau
Ardagh Glass GmbH Werk Germersheim
Ardagh Glass GmbH Werk Lünen
Ardagh Glass GmbH Werk Neuenhagen
Ardagh Glass GmbH Werk Nienburg
Ardagh Glass GmbH Werk Wahlstedt
BA Glass Germany GmbH
Barberini GmbH
BASF Personal Care and Nutrition GmbH Filialstandort Düsseldorf
Bauglasindustrie GmbH
Borax Europe Ltd.
Bucher Emhart Glass SA
Dennert Poraver GmbH
Docter Optics Components GmbH
Duran Produktions GmbH & Co. KG
EME Maschinenfabrik Clasen GmbH
Füller Glastechnologie Vertriebs GmbH
GEA Bischoff GmbH
Gerresheimer AG
Gerresheimer Essen GmbH
Gerresheimer Lohr GmbH
Gerresheimer Tettau GmbH
Glasfabrik Lamberts GmbH & Co. KG
Glashütte Freital GmbH
Glashütte Limburg Gantenbrink GmbH & Co KG
GMB Glasmanufaktur Brandenburg GmbH
Guardian Flachglas GmbH
Heye International GmbH
Horn Bau und Service GmbH
Horn Glass Industries AG
LEDVANCE GmbH–Werk Augsburg
Linde AG Werksgruppe Technische Gase
LÜHR FILTER GmbH & Co. KG
Nikolaus Sorg GmbH & Co. KG
Noelle + von Campe Glashütte GmbH
P-D Industriegesellschaft GmbH–Feuerfestwerke Wetro
P-D Refractories GmbH Niederlassung Dr. C. Otto
Pilkington Automotive Deutschland GmbH
Pilkington Deutschland AG
Pilkington Deutschland AG Werk Gladbeck
Pilkington Deutschland AG Werk Weiherhammer
RHI Glas GmbH
Ritzenhoff AG
Saint-Gobain Glass Deutschland GmbH–Torgau
Saint-Gobain Glass Deutschland GmbH–Aachen
Saint-Gobain Glass Deutschland GmbH–Stolberg
Saint-Gobain Glass Deutschland GmbH–Werk Herzogenrath
Saint-Gobain Glass Deutschland GmbH–Werk Köln-Porz
Saint-Gobain Glass Deutschland GmbH–Werk Mannheim
Saint-Gobain Isover G+H AG–Lübz
Saint-Gobain Isover G+H AG–Ladenburg
Saint-Gobain Isover G+H AG–Bergisch Gladbach
Saint-Gobain Isover G+H AG–Speyer
Saint-Gobain Isover G+H AG–Ludwigshafen
SCHOTT AG–Mainz
SCHOTT AG, Standort Grünenplan
SCHOTT AG, Standort Mitterteich
SCHOTT Technical Glass Solutions GmbH–Jena
Solvay Chemicals GmbH
Spezialglashütte Kugler Colors GmbH
Ullrich GmbH
UniMould GmbH
Verallia Deutschland AG Werk Bad Wurzach
Verallia Deutschland AG Werk Essen
Verallia Deutschland AG Werk Neuburg
Verallia Deutschland AG Werk Wirges (Behälterglas)
Vetropack Austria GmbH Werk Kremsmünster
Vetropack Austria GmbH Werk Pöchlarn
Vetropack Holding AG Sekretariat Gruppenleitung
Vetropack SA St-Prex
Weck Glaswerk GmbH–Bonn
Wöllner GmbH–Ludwigshafen
Zippe Industrieanlagen GmbH
Zwiesel Kristallglas AG



SIMULATION AND MODELING, CYBERSECURITY, IT, AND/OR DATA NETWORKS

D-1.) SciGlass—http://www.sciglass.info/

SciGlass 7.12 is a glass property database containing approximately 400,000 glass compositions from more than 40,500 literature sources and 18,000 patents. The last update appears to have been made in 2014. There is a web and desktop version, and SciGlass offers a 30-day free trial with limited access to 4,500 compositions. However, there is currently no straightforward way to purchase the software. The web version appears to have been last updated in 2008. This database was mentioned in the Functional.

D-2.) Interglad—http://www.newglass.jp/interglad_n/gaiyo/info_e.html

Interglad 7 is an international glass database system developed by the New Glass Forum in Japan. The latest updates appear to be October of 2013. Interg;ad offers three versions: standard, internet, and complete version on CD. The standard/internet versions are an annual contract, whereas the CD version is a one-time purchase.

Interglad User Types and Fees

		Cost (yen/year)	
User type	Fee term	General	Academic
Annual contract	Initial fee	50,000	0
	Annual fee	100,000	50,000
One-time purchase	Price of CD, full-function edition	150,000	75,000

Similar to D-1.) (SciGlass), revival or expansion of Interglad is one of the items in the Functional Glass roadmap.

D-3.) Glass Properties—http://glassproperties.com/databases/

A detailed compilation of glass properties, databases, modeling principles, and other glass-modeling resources developed by Alexander Fluegel, former glass researcher at Pacific Northwest National Laboratory. Although the resource is outdated, it contains valuable information on potential glass resource modeling and publications.

D-4.) International Commission on Glass Atomistic Simulation Committee—http://www.icglass.org/home/technical_committees/committee/?id=25&committee=TC27:_Atomistic_Simulation

The International Commission on Glass (TC 27) was founded in 2009 and focuses on advancing the modeling and simulation of glassy systems. It currently is publishing an introductory book on the fundamentals of glass simulation expected to be published in 2017. The Commision holds regular meetings at international glass conferences to discuss glass-modeling topics of interest.

D-5.) Center for Hierarchical Materials Design (Chimad)—http://chimad.northwestern.edu/

Chimad is a NIST-sponsored center of excellence for advanced materials research focusing on developing the next generation of computational tools, databases, and experimental techniques to enable the accelerated design of novel materials and their integration to industry, one of the primary goals of the U.S. Government's Materials Genome Initiative (MGI). Much of its research efforts focuses on polymeric and metal materials. Partners include Northwestern University, NIST, The University of Chicago, Argonne National Laboratory, Northwestern-Argonne Institute of Science and Engineering, Computational Institute, QuesTek Innovations, ASM International, and Fayetteville State University.

D-6.) Automatic Flow for Materials Discovery (AFLOW)—http://aflowlib.org/consortium.php

AFLOW is a distributed materials repository enabling innovation in materials science through modeling and data infrastructure. AFLOW maintains a database of 1,470,021 material compounds, with more than 133,771,911 calculated properties (and growing). Publications include several on metallic glasses. There are 12 international university research partners.

There are many NIST-funded and smaller initiatives focusing on material simulations/modeling. However, very few have glass in their repositories.

MANUFACTURING AND/OR DEMONSTRATIONS/PILOT STUDIES

M-1.) LG Chem/LG Hausys Efforts—http://www.lghausys.com/

SYNOPSIS

LG subsidiary focuses on industrial materials and their manufacturing. However, the company has an extensive R&D center that truly explores large-scale manufacturing processes and deployment into real-world applications. For instance, LG efforts, particularly in glass, have looked at manufacturing and demonstrations of their glass products for building windows. LG R&D focuses on low-emissivity (low-e) glass production for maximum energy efficiency, and this has been demonstrated in several large buildings within its research park/company campus in Korea. Called the LG Science Park, it will be located within the Magok Industrial Complex in Seoul, Korea, and is set for opening in 2020. The $3.7B investment (4 trillion won) is said to be paid over the course of the construction of the facilities, which are destined to span 170,000 square meters and contain 18 buildings amounting to double the size of LG Group's headquarters in Yeouido, Seoul. The park is said to incorporate more than 7,000 solar-power modules on the buildings that will produce 3 megawatts of energy per hour each. LG claims to have the world's most advanced warm-edge spacer and vacuum glass. Also, because the industry has many influencers (i.e., designers, architects, etc.), LG hosts a Trend Seminar and forums to engage influencers in the design process, which affects the actual glass functions and how they are processed/produced.

NOTES/SPECIFICS

LG Hausys developed single-pane windows with first-grade energy efficiency through the effective convergence of IT technologies. It also is developing platform technology for low-e glass to create "super-insulated triple low-e glass" that offers maximum durability and superior thermal performance. The company also is powerful in efforts surrounding display glass and already considers this a major achievement. Non-alkaline display substrate glass, which is a key material for TFT-LCD and OLED used in TVs, monitors, and portable communication devices, requires a sophisticated technology for producing thin-glass with a highly flat surface. It also requires extremely high quality and process control as compared with the production of conventional soda-lime window glass. An increase in size, a higher resolution of flat-panel display, and a sharp increase of OLED industry result in a high demand of thin glasses less than 0.5-millimeters thick with the improvement of surface quality and thermal stability of glass at high temperature. LG Chem Ltd. currently is producing commercially TFT-LCD substrate glasses. Its R&D division is performing various researches related to the defect analysis, composition and batch control, optimization of process materials, and process simulation with its own glassmelting facilities and analysis instruments to improve the production yield. Also, the R&D division is developing new glasses, such as IT cover glass and solar glass. American manufacturing is located in Adairsville, Ga. According to its site, because North America is the world's largest decorative and automotive materials market, LG Hausys focuses on localizing material businesses centered on such areas as solid surface and automotive skin. LG Hausys operates a HI-MACS factory and a quartz stone (Viatera) factory in Atlanta, Ga. It is making efforts to increase its market share by securing various distribution channels, including the largest building material distributors in the United States. In 2014, LG Hausys also celebrated the groundbreaking ceremony for its automotive skins production plant being built in Atlanta. The plant, once completed, will help LG build a firmer foundation in the American skins market and contribute to increasing its market share. See

http://www.lghausys.com/business/building/window.jsp?gubun=product&pid=32; http://www.lghausys.com/business/building/functionalGlass.jsp?gubun=product&pid=33; http://in.lghausys.com/in/index.jsp; http://www.lgviaterausa.com/; https://www.cresa.com/lg-hausys-america-inc-establishes-us-headquarters-in-cobb-county-with-relocation-of-new-jersey-personnel; and http://www.rnd.lgchem.com/global/main.

M-2.) Consol—http://www.consol.co.za/business/why-consol/product-innovation

SYNOPSIS

Although it is a glass-packaging company, it heavily advertises working on manufacturing process innovations.

M-3.) Rio Tinto Technology Centre—http://www.riotinto.com/canada/rtft/research-centre-15050.aspx

SYNOPSIS

RTFT's Technology Centre (Sorel-Tracy, Quebec, Canada) was founded in 1967. Its mission is to improve processes and products to expand markets and strengthen the competitive value of RTFT's products. The Centre specializes in various science and technology fields, leading-edge equipment, and technology, including a pilot plant that simulates the plant. The research activities touch on all of the company's business areas, from mining to finished products. The Centre invests around $15M annually and has more than 60 employees. The Centre features state-of-the-art equipment and highly specialized instruments, such as inductively coupled plasma spectrometers, X-ray machines, atomic absorption units, gas and image analyzers, and scanning electron microscopes. Rio Tinto has other notable Technology Centers, including its Analytics Excellence Centre (Pune, India), which significantly enhances equipment productivity across its global operations via data-mining innovations. The Analytics Excellence Centre will assess massive volumes of data captured by the array of sensors attached to Rio Tinto's fixed and mobile equipment and enable experts to predict and prevent engine breakdowns and other downtime events, significantly boosting productivity and safety. Data scientists in the Analytics Excellence Centre use predictive mathematics, machine learning, and advanced modeling, to identify a range of problems before they occur. This analysis reduces maintenance costs and production losses from unplanned breakdowns.

NOTES/SPECIFICS

See http://www.riotinto.com/growth-and-innovation-160.aspx and http://www.riotinto.com/media/media-releases-237_14527.aspx.

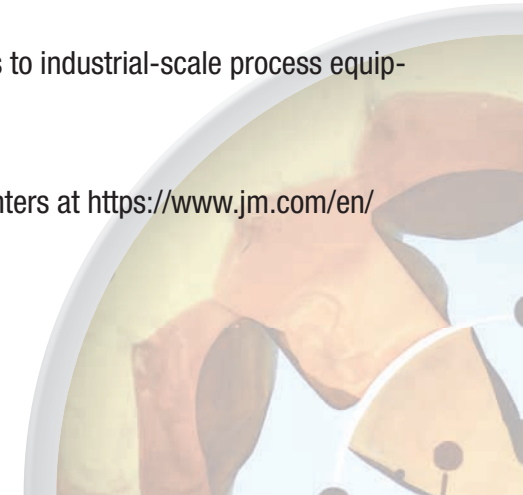
M-4.) Johns Manville Innovation Center—https://www.jm.com/en/innovation-center/r-and-d/

SYNOPSIS

The Johns Manville Innovation Center is a cluster of resources internal to the company that supports R&D efforts. It has access to industrial-scale process equipment, especially furnaces, as well as fiber and nonwoven wet-laid pilot line, binder development, and testing capabilities.

NOTES/SPECIFICS

See project successes that came out of the Center at https://www.jm.com/en/innovation-center/r-and-d/. See five technical centers at https://www.jm.com/en/innovation-center/technical-centers/.



M-5.) The Concrete Network—https://www.concretenetwork.com/glass-fiber-reinforced-concrete/ar-glass-fibers.html

SYNOPSIS

This is a large initiative. It is a free webservice for cement industry suppliers and contractors, with R&D, training, and education for the concrete industry. The network is a subgroup of large corporations. Nippon Electric Glass (NEG), Owens Corning, and Rich Fibers and Systems have individually contributed to the mass use/production of alkali-resistant (AR) glass for glass-fiber-reinforced concrete.

M-6.) Corning Glass Summit—https://www.corning.com/worldwide/en/innovation/culture-of-innovation/glass-summit-2016.html

SYNOPSIS

Although this is more of a think-tank gathering or conference across almost all end users of advanced glass, the Summit is hosted at Corning's headquarters and is tied deeply to its manufacturing capabilities. It is hosted biannually and had 200 attendees in 2016. Also, researchers are invited to take sabbatical in a very formal process—the Gordon Fulcher Sabbatical Program to learn hands-on and access Corning's production facilities.

NOTES/SPECIFICS

See https://www.corning.com/worldwide/en/innovation/culture-of-innovation/fulcher_sabbatical_program.html.

M-7.) Emhart Glass—http://old.emhartglass.com/emhart-glass-research-center

SYNOPSIS

Emhart has an R&D center for its container-forming and testing equipment. The unique center includes an actual glass-manufacturing plant and quality-control laboratories. Built with an investment of around €18M and opened in 2007, the facility at Windsor, Conn., takes hot-end R&D to a new level. The facility helps develop enhanced glass-forming methods, increased automation, and improved yields. As a result, it moves the glass industry forward. Improving the strength of glass containers is an important R&D goal for Emhart Glass. The R&D center includes a complete production line for the manufacture of glass bottles, which allows it to test its ideas in an industrial environment. The line is used to overcome real-world challenges, such as furnace variations, glass property changes, and cooling-wind fluctuations.

NOTES/SPECIFICS

See http://www.ssoe.com/profiles/glass-research-and-development-rd-center/.

M-8.) Owens-Illinois Innovation Center—http://www.o-i.com/uploadedFiles/Content/Newsroom/Company_brochure_ENU_web_FINAL%20(1).pdf

SYNOPSIS

O-I's R&D center is capable of melting and forming glass in a small-scale manufacturing environment and is housed at its global headquarters (Perrysburg, Ohio). The R&D center helps advance new concepts and qualifies emerging technologies that could revolutionize glassmelting and glass forming. In the future, the center will include the ability to prototype product innovations, such as the company's recently launched VersaFlow jar—part of the Versa platform of functional food packages—and the game-changing Vortex bottle. This R&D center is one component of O-I's plans to invest in process and product innovation efforts. The announcement reflects a three-year, $35M investment. Since 2008, investments exceeding $30M have yielded more than 25,000 square feet of R&D training laboratories in the glass-container industry and spurred the release of next-generation manufacturing and inspection equipment. The facility, which is approximately one-tenth the size of a typical manufacturing plant, houses a 20-metric-tonne oxy-fueled furnace, two production lines, and inspection equipment. On one line, through an iterative process of ongoing improvement, sample bottles and trials for new products are made, significantly reducing the time needed to produce exactly the right bottle and minimizing disruption to the manufacturing plants. The other line is dedicated to R&D and is used to develop new technologies and processes for melting and forming glass. In its first eight months of operation, the innovation center team produced more than 40 sample bottles for customers and internal development purposes.

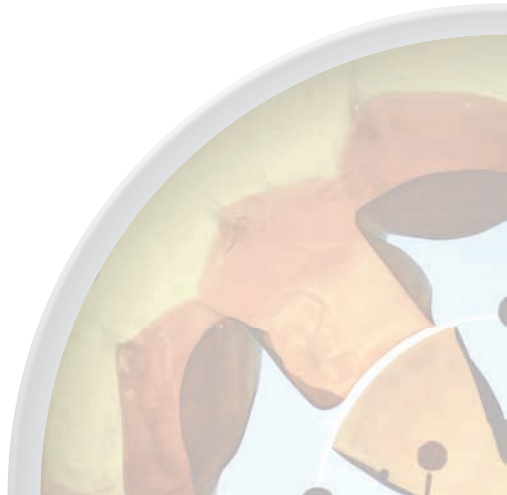
NOTES/SPECIFICS

See http://www.packagingdigest.com/decorative-materials/new-rd-center-advance-glass-packaging-innovations, http://www.o-i.com/Newsroom/O-I-celebrates-early-successes-at-Innovation-Center/, and http://www.beveragedaily.com/Processing-Packaging/Packaging-company-opens-glass-R-D-center.

M-9.) Mini-Consortium Model—http://optics.org/news/3/9/12

SYNOPSIS

Rather than large massive undertakings, small groupings of corporations, such as InnoLas Inc., FiLaser, and Lumera Laser, have crossed continental divides to create manufacturing technologies, such as a brittle-glass-cutting technique. More of these models are occurring.



TECHNICAL/PROFESSIONAL/TRADE GLASS TRAINING

W-1.) My Glass Class—http://myglassclass.com/

SYNOPSIS

Backed by the National Glass Association, My Glass Class focuses on training in basic safety for the glass and glazing industry with 30 course offerings.

CLASS/WORKSHOP TOPICS

Topics include personal protective equipment, safe glass handling, commercial glazing, commercial window installation use, and OSHA 10 and 30 online training.

PRICE RANGES

Glass training courses (free to $44.95) and OSHA courses ($99 to $199). NGA members receive a 30% discounts on list prices.

CLASS LOCATIONS

All courses are available online.

W-2.) Glastory—http://www.glastory.net/resources/

SYNOPSIS

Glastory offers eBooks in a free library, although it asks users to complete a contact form before downloading. Although some topics are technical, most here are marketing/trends related.

CLASS/WORKSHOP TOPICS

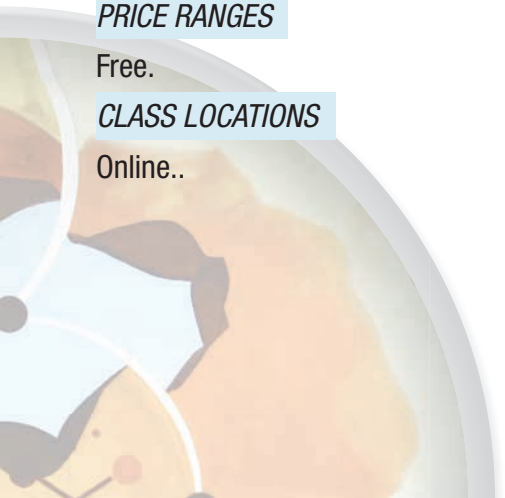
No classes.

PRICE RANGES

Free.

CLASS LOCATIONS

Online..



W-3.) International Materials Institute for New Functionality in Glass Technical Learning Library—http://www.lehigh.edu/imi/teched/library.html

CLASS/WORKSHOP TOPICS

An online glass learning library with video courses, including glass processing, glass energy, chalcogenide glasses, relaxation in glass, properties, characterization, and structure of glasses, U.S.–Japan Winter School, optical glasses, and photonic glasses.

PRICE RANGES

Free.

CLASS LOCATIONS

All available online.

W-4.) International Commission on Glass Summer/Winter School—http://www.icglass.org/home/education/

SYNOPSIS

The International Commission on Glass hosts summer and winter training courses on topics in glass science education and glass technology.

CLASS/WORKSHOP TOPICS

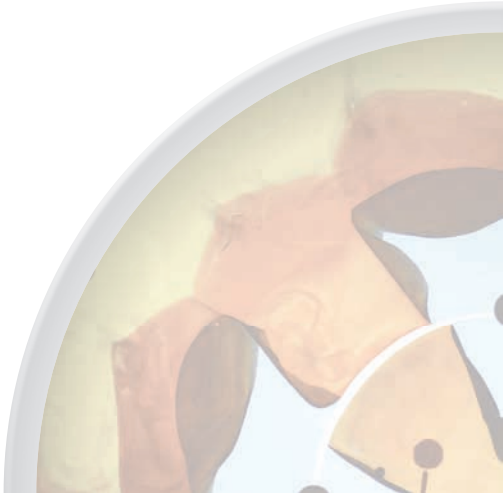
Glass formation, structure, and properties. How numerical modeling can help disentangle key technological challenges in glass.

PRICE RANGES

Normal fee, €800; reduced fee, €300, for students and academic staff.

CLASS LOCATIONS

Université Montpellier, France, and Wuhan University, China.



W-5.) Architectural Glass and Metal Contractors Association Training Center—http://agmca.ca/about-agmca/training-centre/

SYNOPSIS

The Architectural Glass and Metal Technician and Metal Mechanic Apprenticeship Program provides trades people with theoretical knowledge of innovative techniques and procedures associated with the assembly and installation of glazing systems. The curriculum is an 8,000-hour/five-year program that includes three eight-week in-school sessions (basic, intermediate, and advanced).

PRICE RANGES

N/A.

CLASS LOCATIONS

Ontario Industrial and Finishing Skills Centre, Canada.

W-6.) PPG Glass Education Center—http://www.ppg.com/corporate/ideascapes/shared/Pages/continuingeducation.aspx

CLASS/WORKSHOP TOPICS

Glass Production, Processing, and Performance; How Low-e Coatings Improve Building Performance.

W-7.) Guardian Glass Training and Education Programs—http://023app01.guardian.com:16200/Sunguard/SpecificationsResources/AIAContinuingEducationPrograms/index.htm

CLASS/WORKSHOP TOPICS

Windows on Sustainability: How Advanced Glazings Help Buildings Achieve Net-Zero Energy; Principles of Glass Selection for Facades: From Rendering to Reality; LEED and High-Performance Glass; The Evolution of Glass and High-Performance Coatings; The Use of Laminated Glass in Architectural Design; and Glass in Today's Architecture.

PRICE RANGES

Free.

CLASS LOCATIONS

Online.

W-8.) American Glass Research—http://www.americanglassresearch.com/training/seminar-catalogue

CLASS/WORKSHOP TOPICS

Advanced Batch and Furnace Operations; Audit of Glass Plant Operations; Auditor Training for Glass Plant Container Operations; Batch and Furnace Operations; Coating Technology; Cord and Annealing; Evaluation and Lightweighting of Glass Container Designs; Fracture 1: Testing and Breakage Diagnosis of Glass Containers; Fracture 2: Advanced Breakage Diagnosis of Glass Containers; Fracture 3: Glass Fracture Diagnostician Certification; Glass Container Technology; Stones in Glass: Analysis and Identification; and Testing and Fracture Diagnosis of Pharmaceutical Glassware.

PRICE RANGES

$1,200 to $1,450.

CLASS LOCATIONS

Pennsylvania and Ohio, USA.

CUSTOM PLANT CONSULTING FOR WORKFORCE DEVELOPMENT?

Yes.

W-9.) Siemens Glass Manufacturing Training—http://www.industry.siemens.com/verticals/global/en/glass/glass-manufacturing-services/glass-manufacturing-training/pages/default.aspx

CLASS/WORKSHOP TOPICS

Drive Technology; Industrial Automation (Human–Machine Interface, Controls, Analytics, and Instrumentation); Safety Systems. Classes mostly are based on using Siemens products.

PRICE RANGES

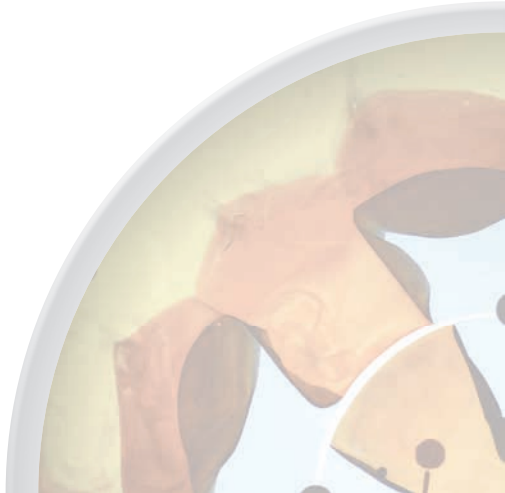
€220 to €2,375.

CLASS LOCATIONS

130 global training centers.

CUSTOM PLANT CONSULTING FOR WORKFORCE DEVELOPMENT?

Yes.



W-10.) IGMA Education Offerings—http://www.igmaonline.org/events/

SYNOPSIS

Periodic, hands-on workshops for either production or testing.

CLASS/WORKSHOP TOPICS

Insulating glass fabrication workshop length is three days. Topics include glass cutting, spacer and IG fabrication, sealant hot melts, adhesion and butterfly test, gas filling and measurement, desiccant, forensics of IG failures, and safety.

PRICE RANGES

$890 (member) to $990 (nonmember).

CLASS LOCATIONS

Ontario, Canada (and previously in Minnesota, USA), held at corporations with the appropriate manufacturing equipment).

W-11.) ACMA Education Offerings—http://www.acmaeducationhub.org/

CLASS/WORKSHOP TOPICS

Many technical topics, including code of standards practice industry guidelines in fabrication and installations for fiber-reinforced products; emissions from molding/other composite processes; automotive applications; fiber sizing; and controlled spraying. Also hosts a couple of pricing- and market-related workshops, especially, Composites Must Dig Down to Open New Markets. Technical certification programs on manufacturing processes tend to be the most expensive. Finally, ACMA hosts several free webinars on wide appealing topics, including learning about the Manufacturing Extension Partnership, engineering laminates, strategies to strengthen businesses, conflict minerals updates, and more.

PRICE RANGES

Free to $395.

CLASS LOCATIONS

Online, except for rare, three-day hands-on training seminar to prepare participants for certification on open molding, vacuum infusion processing, light resin transfer molding, and wind blade repair, held in Rhode Island, USA.

W-12.) CerTev Short Courses—http://www.certev.ufscar.br/education-1

CLASS/WORKSHOP TOPICS

So far, hosted one with ACerS, Nucleation, Growth, and Crystallization in Glasses—Fundamentals and Applications.

PRICE RANGES

$625 (member), $695 (nonmember), and $375 (student).

CLASS LOCATIONS

Held at annual conference of ACerS.

W-13.) CSIR Short Term Courses—http://www.cgcri.res.in/page.php?id=99

CLASS/WORKSHOP TOPICS

Several in glass and ceramics. Glass specific includes guided wave optics and devices.

PRICE RANGES

Only one five-day course was found at 10,000 Rupees (~$150).

CLASS LOCATIONS

All in India.

W-14.) GMIC Short Courses—http://glassproblemsconference.org/short-courses-for-glass-manufacturers/

CLASS/WORKSHOP TOPICS

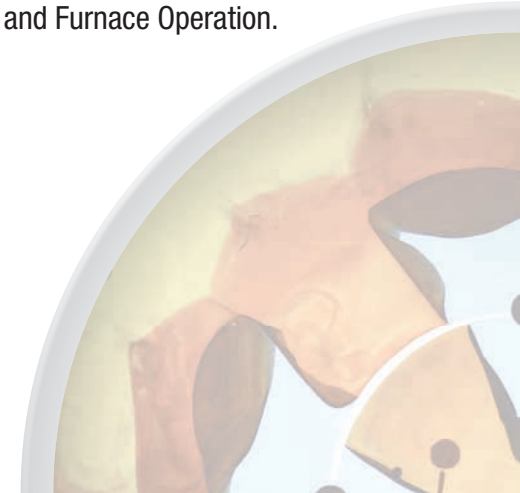
Many topics over the years, but a sample includes Phenomena in Industrial Glassmelting Processes and Fundamentals of Batch and Furnace Operation.

PRICE RANGES

$275 (member) to $325 (nonmember).

CLASS LOCATIONS

Different topics held each year at annual conferences.



W-15.) GlaCERCo-ITN Glass and Ceramic Composites for High-Technology Applications—Initial Training Network (GlaCERCo–ITN)—http://www.glacerco.eu/

SYNOPSIS

An EU-funded project offering multidisciplinary training in the field of high-technology glasses and composites from 2011 to 2015.

CLASS/WORKSHOP TOPICS

Training themes included vitrification of reuse of waste; design synthesis and characterization of special fiber-reinforced composites; design, synthesis, and characterization of special glasses for photonic devices; design, preparation, and characterization of new glasses suitable for medical applications; and glass-based joining and coating of various materials.

PRICE RANGES

Appears to have been free as part of EU's funding.

CLASS LOCATIONS

Throughout Europe (at incubators and universities).

W-16.) ASM International—http://www.asminternational.org/learning/courses/online/-/journal_content/56/10192/1961014/CLASS

CLASS/WORKSHOP TOPICS

Glass Technology Online Course (taught with ACerS). This course is designed to give the student a basic understanding of glass technology. Major emphasis is placed on production technology and glass properties. Also included are sections on commercial glass compositions; glass to metal seals; grinding and polishing; process control; and health and safety issues; and refractory technology.

PRICE RANGES

$582 (member) to $1,391 (nonmember).

CLASS LOCATIONS

Online, except for analytical testing courses, which are taught at the ASM State-of-the-Art Training Center, Materials Park, Ohio, USA.

CUSTOM PLANT CONSULTING FOR WORKFORCE DEVELOPMENT?

Yes.

W-17.) Elan Technology's Glass Science and Technology Course—
https://www.elantechnology.com/about-us/glass-science-course/

CLASS/WORKSHOP TOPICS

Offered over three days and twice a year, the class teaches all aspects of glass to metal seals; covers the manufacturing, properties, and use of sealing glasses; and student tour of an actual plant, observing the processing of raw materials to the finished preforms. An advanced course which details the chemistry, crystallography, mechanical properties, and finite-element analysis of glass to metal seals also is offered.

PRICE RANGES

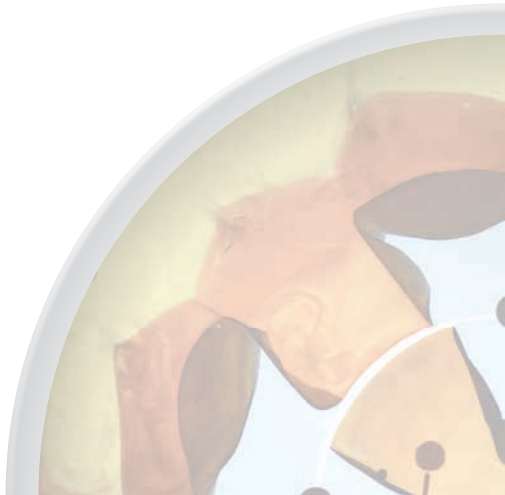
N/A.

CLASS LOCATIONS

At its site in Midway, Ga.

CUSTOM PLANT CONSULTING FOR WORKFORCE DEVELOPMENT?

Yes.



BACHELORS DEGREE PROGRAMS OR COURSES/CONCENTRATIONS IN GLASS/CERAMICS

B-1.) CGIF University–Industry Network

SYNOPSIS

The CGIF University–Industry Network is designed to encourage schools around the world to continue teaching key concepts in ceramic and glass science. This program provides financial and programmatic resources to key professors at participating universities to give their undergraduate students more opportunities to develop an interest in the ceramic and glass fields. In addition, the University–Industry Network helps connect students with champions in industry who use ceramic and glass materials. Funding is available to each university member to support programs and initiatives that deepen a student's understanding of and interest in ceramic and glass materials. Five schools have been selected to pilot the program:

- Alfred University (B.S., Glass Engineering Science)—http://engineering.alfred.edu/undergrad/ges/;
- Clemson University (B.S., Materials Science and Engineering Inorganic Materials Concentration, but no glass courses)—http://www.clemson.edu/cecas/departments/mse/academics/undergraduate/inorganic.html;
- The Colorado School of Mines (B.S., Metallurgical and Materials Engineering Track—Ceramic and Electronic Materials, but no glass courses);
- Pennsylvania State University (B.S., Materials Science and Engineering, but only Introdction to Glass—http://bulletins.psu.edu/undergrad/courses/M/matse/415); and
- Missouri University of Science and Technology (B.S., Ceramic Engineering)—https://mse.mst.edu/undergraduateprograms/ceramicengineering/.

B-2.) Glass Packaging Institute

SYNOPSIS

GPI's Educational Program endeavors to instruct university-level packaging students in the following core areas: glass's key attributes and benefits as a packaging material; the latest in labeling and decorating methods; and case studies that profile consumer products goods (CPG) companies that continue to use/prefer glass packaging. Participants include

- California Polytechnic State University (minor)—http://www.cob.calpoly.edu/undergrad/industrial-technology/packaging-concentration/;
- Clemson University (B.S.)—http://www.clemson.edu/degrees/packaging-science;
  Michigan State University (B.S.)—http://www.packaging.msu.edu/education/undergraduate_information/b.s._degree_program;
- Rochester Institute of Technology (B.S.)—https://www.rit.edu/programs/packaging-science-bs;
- San Jose State University (B.S., Nutritional Science with Concentration in Packaging)—
  http://www.sjsu.edu/nufspkg/programs/bs-nutritional-science/index.html;
- University of Wisconsin-Stout (B.S.)—http://www.uwstout.edu/programs/bsp/;
- University of Florida (B.S.)—http://www.abe.ufl.edu/academics/undergraduate/packaging-engineering.shtml; and
- Virginia Polytechnic Institute and State University (B.S.)—http://packaging.sbio.vt.edu/education/undergraduate/index.html.

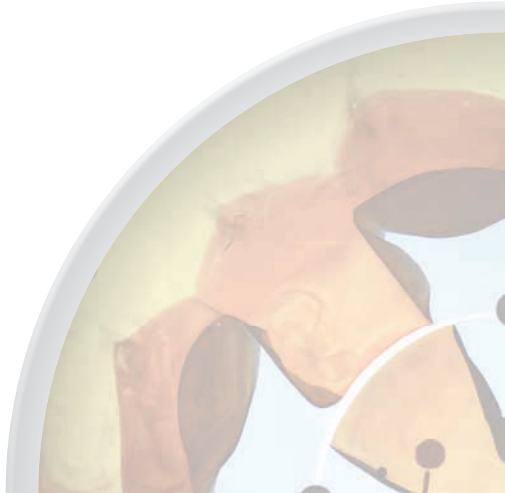
Other schools with glass B.S. programs and/or courses:

- Cornell University (B.S., Materials Science, has an elective course MSE 5320 Glass: Structure, Properties, and Modern Applications).

Interesting article/discussion about curriculum at http://pruffle.mit.edu/~ccarter/GRC99/CerE_debate.html .

MARKETING/SALES TECHNICAL OVERVIEW COURSES OF FUNCTIONAL GLASSES

None can be found other than perhaps W-11 and W-16 (but content access not avalable).



OTHER AREAS AFFECTING GLASS INDUSTRY

O-1.) Energy Star Energy Efficiency Tools—https://www.energystar.gov/buildings/facility-owners-and-managers/industrial-plants/measure-track-and-benchmark/energy-star-energy-6

SYNOPSIS

Industrial Efficiency Technology Database at http://ietd.iipnetwork.org/content/glass#organizations.

O-2.) Insurance and Risks—http://www.nipgroup.com/programs/glasspro/; http://www.inchem.org/documents/iarc/vol58/mono58-4.html; http://www.magidblog.com/industry-posts/manufacturing/glass-manufacturing/

SYNOPSIS

Publications and conferences that share topics on bioglass risks in vivo. International Society for Trace Element Research in Humans. International Conference on Interfaces in Medicine.

O-3.) Various State Initiatives to Combat Glass Manufacturing Air Pollution

SYNOPSIS

Oregon at http://www.deq.state.or.us/aq/planning/report/appendix/GlassManufacturingWP.pdf. California at https://www.arb.ca.gov/cc/glass/glass.html.

O-4.) Society for Biomaterials—https://www.biomaterials.org/

SYNOPSIS

This interdisciplinary gathering is a critical pathway to identifying issues with current technologies and for translating academic research to clinical practice.

O-5.) International Society for Ceramics in Medicine—https://bioceramics.org/about/executive-commitee/

SYNOPSIS

Applied Research Center The Advanced Ceramics and Glass Laboratory emphasizes specialty materials used in a variety of ways and evolves around a core product and competency, involving porous-wall hollow-glass microspheres (PWHGMs). These tiny unique materials are glass microballoons, 2 to 100 micrometers in diameter (one-half to one-third the diameter of a human hair) that have very thin outer shells 1 to 2 micrometers thick. Their potential applications include

- Drug delivery;
- MRI contrast agents;
- Agent transport systems; and
- Platforms in regenerative medicine.

See http://www.discoverarc.com/research/ceramics/.

B.) Analogous Manufacturing Consortiums and/or Programs from Around the World

The following defined strategy emerging from the ACerS roadmapping efforts is very similar to other consortiums or manufacturing organizations strategies:

- Characterizing materials, structures, and properties
- Modeling and simulating performance
- Optimizing manufacturing processes
- Data infrastructure and best practices
- Workforce development and coordination.

These consortiums and programs to present information on successful outcomes, business models, membership numbers, intellectual property plans, and other collaboration concepts, etc. Some are currently existing consortia/programs, others may be no longer active.

A-1.) National Network of Manufacturing Institutes—AKA 'Manufacturing USA' Network

Although there are at least nine networks as of Q1 2017, the following are those most analogous to the scope of ACerS roadmap. However, in the Appendix of this report, please find business/membership and IP models for other NNMIs beyond those listed below.

Institute for Advanced Composites Manufacturing Innovation—http://iacmi.org/about-us/

SYNOPSIS

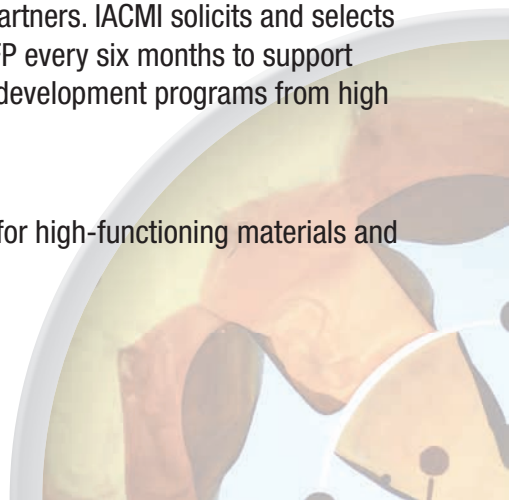
IACMI is committed to delivering a public–private partnership to increase domestic production capacity, grow manufacturing, and create jobs across the U.S. composites industry. Its collaboration of industry, research institutions, and state partners is committed to accelerating development and adoption of cutting-edge manufacturing technologies for low-cost, energy-efficient manufacturing of advanced polymer composites for vehicles, wind turbines, and compressed gas storage. CCS is a not-for-profit organization established by the University of Tennessee Research Foundation. The national institute is supported by a $70M commitment from the U.S. Department of Energy's Advanced Manufacturing Office, and more than $180M is committed from IACMI's partners. IACMI solicits and selects project proposals that advance the application and deployment of high-impact advanced composites. IACMI plans to offer an RFP every six months to support projects of varying size, duration, commercialization potential, and cost-share commitments. It also has very strong workforce development programs from high school through professional training.

SIGNIFICANCE/SIMILARITIES

This is likely the closest NNMI to what type of consortium ACerS wants to build. It is a subset of a commodity product (plastics) for high-functioning materials and their end-use application development. It also heavily focus on recyclability of these materials.

SUCCESSFUL OUTCOMES

Too soon to tell, although it has awarded at least one round of R&D RFPs to members.



NOTABLE INDUSTRY PARTNERS/MEMBERS

Charter members include Dassault Systemes, DowAksa USA, Ford, and Lockheed Martin. Premium members include Airbus, Arkema, BASF, Continental Structural Plastics (CSP), Cytec Engineered Materials, Dupont, Evonik, GE Power and Water, Heil Trailer International, Honda, Huntsman Polyurethanes, Local Motors, PPG, SABIC Innovative Plastics, Volkswagen, and Xperion. Other members include 3M, Adama, ARM, Asahi Kasei, Cabot, Cannon, Eaton, Dow, FibrTec, Georgia-Pacific, ELG Carbon Fiber, John Deere, Johns Manville, JECO, Janicki, United Technologies, and Siemens Wind.

MEMBERSHIP/BUSINESS MODEL

IACMI membership is a tiered structure with a five-year commitment that provides a range of benefits on important issues, such as strategic planning, roadmapping, and development of projects. All IACMI members may participate in projects regardless of their membership level. The membership fee structure is based on company size and willingness to partner on technology development for composite materials. Members must sign the membership agreement containing specific rights and responsibilities.

Charter Members	Premium Members	Resource Members	Consortium Members
Required investment: • $5 million over 5 years • At least 50% in cash • $100,000 cash annually toward IACMI overhead expenses	**Required investment** • $1 million over 5 years • At least 50% in cash • $20,000 annually toward IACMI overhead expenses	**Required investment:** • Provide resources (e.g. equipment, materials, or software) as cost share • Donated resources must be of value to IACMI • Must execute a Consortium Level Membership Agreement	**Required investment:** • $5,000 annually for industry with ≤500 employees and educational institutions • $10,000 annually for industry with >500 employees

Benefits:
• Cash contribution eligible for match subject to available funds
• Leverage significant intellectual and resources capabilities
• Influence in creation and direction of IACMI
• Participation in governance
  ◦ All Charters have a Seat on the Board
  ◦ Elect one rep for the Technical Advisory Board
• Rapid access to shared RD&D facilities
	Benefits:
	• Cash contribution eligible for match subject to available funds
	• Participation in governance
	  ◦ Elect one rep for the Board
	  ◦ Elect one rep for the Technical Advisory Board
	• Leverage significant intellectual and resources capabilities
	• Enterprise-wide proprietary projects
		Benefits:
		• Right to use unique modifications to their technology
		• Exposure to potential customers
		• Participate in projects to improve their products
			Benefits:
			• Opportunities to engage
			• Opportunities to build key relationships
			• Opportunities to participate in governance
			  ◦ Elect one SME rep for the Board
			  ◦ Elect one SME and one Large Co. rep for the Technical Advisory Board
			• Opportunities to fuel your company's growth within the composites ecosystem

IP POLICY

Please see attachments for thorough IP model.

ORGANIZATION TYPE

501(c)3 with a Board of Directors and Federal Advisors and three Advisory Boards (Economic Development, Technical Advisory, and Workforce Advisory). Incorporated as CCS Corp., a wholly-owned subsidiary of the University of Tennessee Research Foundation.

ORIGINAL LEAD(S)

University of Tennessee, Knoxville, and Oak Ridge National Laboratory.

HQ/MAJOR LOCATIONS

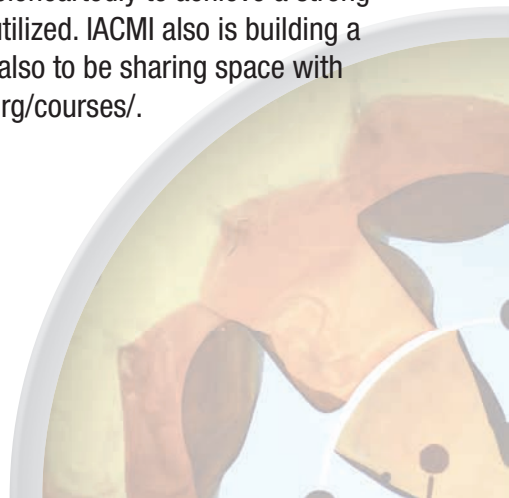
Knoxville, Tenn., with somewhat geographically spread facilities to support random applications and design areas.

HEAD EXEC BACKGROUND

Craig Blue is the founding CEO, but he is not permanent. Blue is the director of Energy Efficiency and Renewable Energy Programs for the Energy and Environmental Sciences Directorate at Oak Ridge National Laboratory. The Energy Efficiency and Renewable Energy Portfolio at ORNL represents significant DOE program investments in areas including the Advanced Manufacturing Office, Building Technologies Office, and Vehicle Technologies Office, and it capitalizes on ORNL's world-class user facilities, such as the Spallation Neutron Source, Center for Nanophase Materials Science, Building Technologies Research and Integration Center, Carbon-Fiber Technology Facility, Manufacturing Demonstration Facility, and National Transportation and Research Center. He has more than 21 years of experience in conducting research in materials and manufacturing technologies, has authored almost 100 open-literature publications, holds 15 U.S. patents, and has received multiple awards, including 10 R&D 100 Awards. He has served by invitation on numerous scientific and technical review panels, committees, and convocations convened by the National Science Foundation, Council on Competitiveness, Manufacturing USA, and National Academies of Sciences and Engineering. He is a Battelle Distinguished Inventor, Fellow of ASM International, holds faculty appointments at the University of Tennessee, University of North Texas, and the Colorado School of Mines.

NOTES

IACMI hired a chief commercialization officer who has a background of more than 30 years experience in sales, marketing, engineering, and manufacturing of chemicals, plastics, and composite materials for automotive, aerospace, industrial, and recreation. I agree with this concept wholeheartedly to achieve a strong consortium. It also is interesting to see an economic development council help with the state funding model this group initially utilized. IACMI also is building a modeling/simulation 30,000 square foot facility in a new manufacturing center being built in partnership with Indiana. It seems also to be sharing space with fellow NNMI LIFT. See http://iacmi.org/wp-content/uploads/2015/11/IACMI-Overview-Nov-2015-Website.pptx and http://iacmi.org/courses/.



Digital Manufacturing and Design Innovation Institute—http://dmdii.uilabs.org/

SYNOPSIS

DMDII's mission is to revitalize American manufacturing by helping U.S. manufacturers harness digital advancements and data to make their products better, faster, and more cost competitive. It has an investment of more than $80M to date from the Department of Defense matched with $250M. DMDII now has approximately 230 member organizations, including best-in-class global manufacturing and technology companies, more than 40 universities across the U.S., and more than 140 small- and medium-sized manufacturers and digital enterprises. The Institute will develop and demonstrate digital manufacturing technologies and deploy and commercialize these technologies across key manufacturing industries. DMDII offers three distinct pockets of services/opportunities around this technology topic: R&D by participating in project teams; manufacturer outreach by assessing companies' digital capabilities and benchmarking against similar manufacturers; and workforce development.

SIGNIFICANCE/SIMILARITIES

Because this Institute covers modeling and simulation throughout multiple industries, it may already cover, or can be approached to make new topics in modeling/simulation in the glass industry. Relevant R&D areas awarded or open topics are real-time optimization of factory operations, low-cost robotics and automation, seamless work flows from design to fabrication, analytical solutions for lifecycle feedback (this would be ideal for recycling topics on cullet, etc.), and smart factory visibility and real-time optimization.

SUCCESSFUL OUTCOMES

Jury is still out. DMDII claims it has released three project call workshops and facilitated $50M in applied research projects, but no outcomes available on those efforts back to industry as yet.

NOTABLE INDUSTRY PARTNERS/MEMBERS

Boeing, Caterpillar, Deere and Co., Dow Chemical, GE, Illinois Tool Works, Lockheed Martin, Microsoft, PARC, Proctor and Gamble, Rolls-Royce, and Siemens PLM.

MEMBERSHIP/BUSINESS MODEL

INDUSTRY TIER 1

BENEFITS

- Seat on Executive Committee
- Seat on Technical Advisory Committee
- Help steer the Institute's agenda
- Royalty-free use of IP from all Enterprise projects for internal R&D and internal operations worldwide
- Participation in R&D projects
- Networking opportunities

OBLIGATIONS

- 5-year commitment to $400,000 annual membership fee
- At least $3 million in expenditures for Enterprise-Wide or Corporate Interest Projects over 5 years

INDUSTRY TIER 2

BENEFITS

- Representation on Executive Committee (2 seats to represent all Tier 2 Industry Partners)
- Seat on Technical Advisory Committee (TAC)
- Help steer the Institute's agenda
- Royalty-free use of IP from all Enterprise projects for internal R&D
- Participation in R&D projects
- Networking opportunities

OBLIGATIONS

- 5-year commitment to $200,000 annual membership fee

INDUSTRY TIER 3

BENEFITS

- Representation on Executive Committee (1 seat to represent all Tier 3 Industry Partners)
- Participation in R&D projects
- Networking opportunities

OBLIGATIONS

- 5-year commitment to $500 annual membership fee
- Commitment to advance objectives of DMDII
- Commitment build digital capacity within your own organization

ACADEMIC / NON-PROFIT TIER 1

BENEFITS

- Seat on the Executive Committee, (but all academic members cannot exceed one-third of total EC membership)
- Seat on Technical Advisory Committee (TAC)
- Help steer the Institute's agenda
- Royalty-free use of IP from all Enterprise projects for internal R&D worldwide
- Participation in R&D projects
- Networking opportunities

OBLIGATIONS

- At least $5 million in expenditures aligned with mission of DMDII that must qualify as Cost Share under Cooperative Agreement over the 5-year period.

ACADEMIC / NON-PROFIT TIER 2

BENEFITS

- Representation on Executive Committee (2 seats to represent all Tier 2 Academic Partners, but all academic members cannot exceed one-third of total EC membership)
- Seat on Technical Advisory Committee (TAC)
- Help steer the Institute's agenda
- Royalty-free use of IP from all Enterprise projects for internal R&D worldwide
- Participation in R&D projects
- Networking opportunities

OBLIGATIONS

- At least $2 million in expenditures aligned with mission of DMDII that must qualify as Cost Share under Cooperative Agreement over the 5-year period.

IP POLICY

The IP that is created within its R&D projects will be made available to Tier 1 Industry Partners on a royalty-free basis for use in their internal operations and research activities worldwide. Tier 2 Industry Partners will enjoy similar rights to the IP, but only for their internal research purposes. Please see attachments for thorough IP model for the full model.

ORGANIZATION TYPE

501(c)3.

ORIGINAL LEAD(S)

University of Illinois, World Business Chicago, City of Chicago, and State of Illinois.

HQ/MAJOR LOCATIONS

Chicago, Ill., housed in a large 94,000 square foot University of Illinois hosted building that boasts an accelerator as well.

HEAD EXEC BACKGROUND

Dean Bartles served as the founding executive director for the Digital Manufacturing and Design Innovation Institute in Chicago and the chief manufacturing officer of UI LABS. Prior to these recent assignments, he served as a vice president at General Dynamics Corp., where his career spanned more than 30 years and included profit-and-loss responsibility for three manufacturing plants as well as managing the establishment of two manufacturing operations overseas. Bartles has more than 38 years of management experience, which has included positions with Fairchild Republic Co., General Defense Corp., Olin Ordnance, Primex Technologies, General Dynamics, and UI LABS. He was elected an SME Fellow in 2012. Bartles also serves on the Industry Advisory Board of ASME, where he became a Fellow in 2012, and currently serves as chair emeritus of the Board of Directors of the National Center for Defense Manufacturing and Machining and chair emeritus of the Board of Directors of the Smart Manufacturing Leadership Coalition. Additional boards Bartles serves are the MT Connect Institute, Board

of Governors of Manufacturing Leadership Council, Louisiana Center for Manufacturing Sciences, and Industry Advisory Boards at Pennsylvania State University, Iowa State University, Indiana State University, Pittsburgh State University, and East Carolina University. He previously served on the Board of Directors of the National Center for Manufacturing Sciences, Manufacturing Enterprise Solutions Association, Forging Defense Manufacturing Consortium, American League of Export Security Assistance, Manufacturing Division of the National Defense Industrial Association, Department of Commerce's Manufacturing Council, and Defense Industry Offsets Association. Additionally, Bartles was part of President Obama's Economic Recovery Advisory Board's Education and Training Subcommittee, U.S. State Department's Defense Trade Advisory Group, and Army Research and Development Advisory Committee. He graduated from Shepherd College with a B.S. in business administration, holds an MBA from Shippensburg University, and a M.S. in international business from Tampa College. Bartles also earned a Ph.D. in business administration from Nova Southeastern University and a Ph.D. in technology management with a concentration in manufacturing systems from Indiana State University.

NOTES

A long list of awarded and open projects is found at http://dmdii.uilabs.org/projects. DMDII is developing an open-source software tool that will be an open architecture communication platform and which will enable plug-and-play functionality across the entire digital thread. This software is being called the Digital Manufacturing Commons, or DMC. See http://www.projectdmc.org/ and
https://www.whitehouse.gov/blog/2016/06/17/digital-manufacturing-and-design-innovation-institute-dmdii-virtual-tour.

Lightweight Innovations for Tomorrow (LIFT)/American Lightweight Materials Manufacturing Innovation Institute—http://lift.technology/

SYNOPSIS

LIFT is operated by ALMMII. ALMMII was selected through a competitive process led by the U.S. Department of Defense under the Lightweight and Modern Metals Manufacturing Innovation (LM3I) solicitation issued by the U.S. Navy's Office of Naval Research. ALMMII is one of the founding institutes in the National Network for Manufacturing Innovation, a federal initiative to create regional hubs to accelerate the development and adoption of cutting-edge manufacturing technologies. The LIFT consortia is regional in nature, but serves the entire nation by involving more than 200 companies, universities, nonprofit research institutions, and workforce development intermediaries from around the country. LIFT is a public–private partnership that develops and deploys advanced lightweight materials manufacturing technologies for defense and commercial applications and implements education and training programs to prepare the advanced manufacturing workforce for jobs in the application of innovative lightweight metal production and component/subsystem manufacturing technologies. The Institute's mission is to serve U.S. manufacturing by acting as the bridge between basic research and final product commercialization of new, advanced lightweight materials and innovative manufacturing technologies and practices. This enables the development of cost-effective lightweight components for the defense, aerospace, automotive, sea, and over-the-road truck industries. Priorities for LIFT are defined by technology, workforce, and economic development needs for the defense and commercial industrial sectors, with particular focus on transportation requirements. LIFT's scope of activity includes more than $100M in technology projects undertaken by its industry and university partners, and, within five years, these activities are expected to have an impact on the supply chain of approximately 10,000 jobs in the metal-stamping, metalworking, machining, and casting industries. LIFT also facilitates technology commercialization through improvements in manufacturing processes, working with incubators to assist startups bringing new technologies to market and other technology transition efforts through its network partners.

SIGNIFICANCE/SIMILARITIES

This NNMI also focuses on a material class (metals) and its manufacturing. Therefore, it is analogous to FGMIC's goals. LIFT is an NNMI to already claim some success and stay close to the mission. However, it is funded by DOD, and glass would be hard to come by DOD funding. Melting, coatings, powder processing, and thermomechanical processing are critical pillars for the NNMI as well.

SUCCESSFUL OUTCOMES

Using next-generation metals manufacturing techniques, LIFT, the Detroit institute, has focused on lightweight metals. It has successfully reduced the weight of core metal parts found in cars and trucks by 40%, improving fuel efficiency and saving consumers dollars at the pump. In addition, LIFT has introduced curricula in 22 states to train workers on the use of lightweight metals. During summer 2017, 38 companies are expected to host students in paid manufacturing internship in partnership with LIFT.

NOTABLE INDUSTRY PARTNERS/MEMBERS

Alcoa, GE, Boeing, Eaton, Comau, Nemak, Metalsa, Lockheed Martin, Materion, United Technologies, DNV-GL, Greene, and Tenneco.

MEMBERSHIP/BUSINESS MODEL

LIFT membership is a tiered structure with a five-year commitment. Currently the commitment requires a minimum cash value with the remaining as in-kind.

IP POLICY

See attachment in appendix of report.

ORGANIZATION TYPE

A 501(c)3 founded by Ohio-based manufacturing technology nonprofit Edison Welding Institute, which is an unusual model—most have been started by universities. EWI is 32 years old and has provided applied research, manufacturing support, and strategic services to leaders in the aerospace, automotive, consumer products, electronics, medical, energy and chemical, government, and heavy-manufacturing industries.

ORIGINAL LEAD(S)

EWI, University of Michigan, and The Ohio State University.

HQ/MAJOR LOCATIONS

Rosa Parks Blvd. in Detroit, Mich., with significant activities in Columbus, Ohio. The Michigan building is under retrofitting construction to build for NNMI.

HEAD EXEC BACKGROUND

Lawrence E. Brown has more than 30 years of manufacturing, applied R&D, and technical project management experience with the U.S. government and commercial programs. Throughout this time he has gained a working knowledge in various joining processes for metal alloys—ightweight and high-temperature superalloys. His efforts have led to advanced joining methodologies for fabrication of advanced military and commercial engine hardware and have yielded six patents as coinventor. As the executive director of LIFT, Brown is responsible for day-to-day management and leadership of the organization, including interface with the ONR Government Program Manager. He was most recently employed by EWI for 14 years and most recently served as that organization's director of

government technology programs. Previous to this role, he held several leadership positions as director of the Project Management Office and Engineering. He also has served as the director of the Navy Joining Center (NJC), where his responsibilities included planning and control of NJC technology development projects in support of the Office of Naval Research (ONR) ManTech Program. Brown received a B.S. in welding engineering and M.S. in management from Indiana Wesleyan University. Brown is assisted by a chief innovation and transition officer, Dan Kramer, but there is no information available about him.

NOTES

LIFT has created very smart marketing collateral on return on investment strategies for participants, see http://lift.technology/wp-content/uploads/2014/06/LIFT-ExecutiveSummary-2015.pdf. Another smart idea is a hosted survey to gauge smaller player interest in the NNMI, see http://lift.technology/wp-content/uploads/2014/06/LIFT-Survey-Summary-Flyer-1204.pdf.

Workforce efforts at http://lift.technology/wp-content/uploads/2014/06/LIFT_WorkforceEducation-Overview.pdf, https://ewi.org/about/, https://ewi.org/ewi-to-lead-new-national-lightweighting-institute-in-michigan/, and http://www.mlive.com/business/detroit/index.ssf/2015/01/148_million_lightweight_materi.html.

Smart Manufacturing Leadership Coalition (SMLC)/Clean Energy Smart Manufacturing Innovation Institute—https://smartmanufacturingcoalition.org/

SYNOPSIS

SMLC will focus on innovations, such as smart sensors that can dramatically reduce energy expenses in advanced manufacturing, making its manufacturing sector strong today and positioning the U.S. to lead the manufacturing of tomorrow, helping sustain the resurgence of U.S. manufacturing currently underway. The Coalition will bring together almost 200 partners and more than $140M in public–private investment from leading universities and manufacturers, to launch the Smart Manufacturing Innovation Institute, focused on accelerating the development and adoption of advanced sensors, data analytics, and controls in manufacturing, while reducing the cost of these technologies by one-half and radically improving the efficiency of U.S. advanced manufacturing. Although NNMI is underway, SMLC has been around for at least 15 years and has received significant federal funds to work on an Open Smart Manufacturing Platform and Marketplace enabling manufacturing companies of all sizes to gain easy, affordable access to modeling and analytical technologies that can be tailored to meet cross-industry business-case objectives without having to retrofit existing systems. Most of the SMLC's expertise and focus, as will be similar for the NNMI's, is on the cyber-physical aspects of manufacturing and supply chain versus tangible hardware and manufacturing centric solutions to reducing energy inefficiencies and emissions (which was the scope of the DOE's FOA). There were two early collaborative testbeds with industry projects that were funded by DOE for the original SMLC: Steam Methane Reforming, with Praxair; and Fabrication of Precision Metal Parts, with Alcoa. PPTS (which can be made available in the Appendix if desired) shows no outcomes of success. It has a very loosely based testbed infrastructure, although it has used commercial plants' facilities in at least four projects over SMLC's existence.

SIGNIFICANCE/SIMILARITIES

Although this NNMI is not in existence and SMLC mostly focuses on software/policies for energy and emission efficient manufacturing, including for the glass industry, the new NNMI may have some overlap to objectives listed in the FGMIC roadmap.

SUCCESSFUL OUTCOMES

Too early to tell for the NNMI, but SMLC has been funded more than $20M from DOE and industry with few to no successes.

NOTABLE INDUSTRY PARTNERS/MEMBERS

No members have actually paid as yet, but industry members reported as part of its proposal include Aerospace Corp., Alcoa, Analog Devices, ANSYS, ArcellorMittal, Autodesk, BASF Corp., Bonneville Power Administration, Corning, Emerson Process Management, ExxonMobil, General Mills, Global Foundries, Google, KUKA Systems North America, Microsoft, Northrop Grumman, OSIsoft, Pfizer, Praxair, Rockwell Automation, Saint-Gobain, Southern California Edison, United States Steel Corp., United Technologies Research Center, and SMLC. The current coalition has additional members not listed with the NNMI (3M, Danfoss, General Dynamics, GM, Schneider Electric, and Honeywell).

MEMBERSHIP/BUSINESS MODEL

This NNMI likely will be a tiered membership structure, but details have not been released as yet. SMLC's membership is based on tiered dues.

Fee Structure

Membership Level / Size	Board	Project	Associate
Large Company	$30,000	$15,000	$5,000
Small Company	$10,000	$5,000	$2,500
Affiliate	$3,000	$1,500	$1,000

Board members may serve on the SMLC board and may participate in the setting of overall SMLC priorities; decision making regarding all SMLC projects; use of SMLC funds; and have nonexclusive rights in the patenting and licensing of intellectual property developed by member funded projects. Board members may participate in SMLC projects and pilot test emerging technologies. Board members may attend general SMLC workshops, symposia, and networking events at reduced rates and have access to SMLC reports, research papers, general documentation, and strategic documents. Board members have full voting rights. Project members may participate directly as a member of SMLC project teams in the development and execution of proposals, technology development, and pilot-test emerging technologies. Project members have nonexclusive rights in the patenting and licensing of intellectual property developed by member-funded projects. Project members may participate in general SMLC workshops, symposia, and networking events at reduced rates and have access to SMLC reports, research papers, general documentation, and strategic documents. Associate members may participate in general SMLC workshops, symposia, and networking events at reduced rates and have access to SMLC reports, research papers, general documentation, and strategic documents.

IP POLICY

Not released yet.

ORGANIZATION TYPE

At this time, SMLC is 501(c)6 and will likely keep CESMII under it (versus incorporating a new org).

ORIGINAL LEAD(S)

SMLC (nonprofit already existing) and UCLA.

HQ/MAJOR LOCATIONS

Los Angeles, Calif., at UCLA. It also will have a Berkeley-based regional center. It also intends to launch five regional manufacturing centers (California, Washington, New York, North Carolina, and Texas) across the U.S., each focused on local technology transfer and workforce development.

HEAD EXEC BACKGROUND

Denise Swink retired from federal service in 2004 after 35 years experience spanning a variety of programs at the U.S. Geological Survey, U.S. Environmental Protection Agency, and U.S. Department of Energy. She is currently serving as an independent consultant to private sector, government, and nonprofit organizations. At the Department of Energy, Swink held positions as director, Office of Planning and Environment, Office of Fossil Energy; deputy assistant secretary, Office of Industrial Technologies, Office of Energy Efficiency and Renewable Energy; and deputy director and acting director, Office of Energy Assurance. The past two decades Swink held management/supervisory positions, and the past decade, she was a member of the Senior Executive Service. Swink has worked at the highest levels of government and the private sector, nationally and internationally, on topics including fossil energy technology advancement for extraction, transport, and utilization of resources; manufacturing productivity and efficiency with emphasis on technology advancement and adoption; electricity infrastructure development; and safety and reliability of the entire energy infrastructure. To enhance the efficiency and competitiveness of industry, Swink created and led extensive public–private partnerships with private, state, and academic entities to develop strategies promoting innovation; create, fund, and implement plans; and monitor results and effectiveness. Private sector participants ranged from CEOs to plant operation personnel. The energy infrastructure is the bedrock infrastructure for the resilience of all other critical infrastructures, and Swink has substantial knowledge of its interdependency among these infrastructures, such as banking and finance, telecommunications, water systems, agriculture, and manufacturing operations. She holds a B.S. in mathematics from American University and M.S. in environmental sciences from Johns Hopkins University. Swink currently is the vice chair of the National Materials and Manufacturing Board and National Academy of Sciences, and she participates on the Defense Materials, Manufacturing, and Infrastructure Standing Committee there. Swink also is chair of the board of Smart Manufacturing Leadership Coalition and a senior advisor to the U.S. Resilience Project.

James Davis is vice provost of IT and CTO, an executive leadership role with broad responsibilities focused on UCLA's academic research and education mission but building on his past position as associate vice chancellor and CIO. Davis has responsibilities for the Institute for Digital Research and Education (IDRE), Institute for Informatics, UCLA's institutional educational technology initiatives, as well as broad accountability for university-wide IT planning and strategic investment in academic and administrative operations and services. Included in his portfolio are UCLA's digital presence, cyberinfrastructure, and high-performance computing, informatics, and networking, the internal focus of these for research and education and their external focus in various UCLA partnerships. Davis is a member of the Coalition of Academic Scientific Computing, University of California IT Leadership Council, and Governing Body of the Southern California CIO Executive Summit. Davis is coleader on a national initiative on Smart Manufacturing and U.S. manufacturing competitiveness and the launch of the Smart Manufacturing Leadership Coalition (SMLC) in Washington, D.C. The SMLC is comprised of companies, universities, and manufacturing consortia focused on the pervasive application of advanced intelligent systems to enable rapid manufacturability of new products, dynamic response to product demand, and real-time optimization of all aspects of production and supply chain networks. Davis is currently on the board of SMLC Inc. and director of technology. Davis also sits on the boards of the Manufacturing Leadership Council, CACHE (Computer Aids in Chemical Engineering) Corp., and UCLA IS Associates, bringing together the IT leadership of approximately 50 For-

tune 500 companies in Southern California. Davis is the past chair of the Board of Directors of CENIC (Corporation for Education Network Initiatives in California), the nonprofit corporation responsible for network connectivity and services to all higher education and K-12 institutions in the state. Davis is a professor in the Department of Chemical and Biomolecular Engineering at UCLA. His research is in the area of data analysis, decision support, and intelligent systems. With more than 30 years experience in technology-based engineering research and application, he has been involved with research, development, and deployment of information technology solutions in a variety of industrial applications. Prior to his appointment, Davis served as CIO, associate provost for IT, and director of University Technology Services at The Ohio State University. At Ohio State, he had responsibility for institutional IT planning, instructional technology, policy, faculty/staff/student IT advisory committees, and all central infrastructure and support services for academic and administrative applications. He worked extensively with the Ohio Supercomputer Center, the Ohio Academic and Research Network (OARnet), the Committee on Institutional Cooperation (CIC), and Internet2 on computing, network, research, and educational initiatives.

NOTES

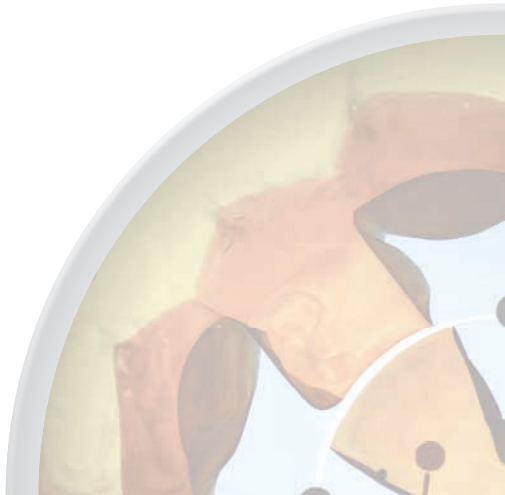
See technical areas at https://smartmanufacturingcoalition.org/reading-materials/presentations-workshop-materials. For more information on testbeds, see https://smartmanufacturingcoalition.org/testbeds-projects-awards.

Other NNMIs

Other NNMIs, such as America Makes (3D printing of flex electronics, textiles, photonics, and power devices), are not listed because they are not material- or commodity-only focused. However, all of the membership/IP policies available for these NNMIs can be found in the appendix.

NOTES

See https://www.manufacturing.gov/nnmi-institutes/.



A-2.) SEMATECH

SEMATECH was the nation's largest manufacturing-based private–public partnership consortium. It is in the final stages of its existence, having started in the 1980s and achieved its original goals. It was never replicated again when introduced to other markets/technologies as a major theme—most notably photovoltaics—but its original business model, IP policies, and sustainability pursuits led to significant wins for the U.S. economy in semiconductors manufacturing. Since 2011 and still today, The Center of Excellence in Nanoelectronics and Nanotechnology at SUNY Polytechnic Institute's Colleges of Nanoscale Science and Engineering is the location for the worldwide headquarters and operations of SUNY Poly SEMATECH, a 12-member consortium of major computer chip manufacturers. SUNY Poly SEMATECH coordinates and oversees next-generation research, development, and commercialization programs in lithography, interconnects, and metrology, among others, while managing global reach and influence through various program partnerships worldwide in emerging nanotechnology-driven applications, such as nanobiotechnology and sustainable energy. SEMATECH was conceived in 1986, formed in 1987, and began operating in Austin, Texas, in 1988 as a partnership between the U.S. government and 14 U.S.-based semiconductor manufacturers to solve common manufacturing problems and regain competitiveness for the U.S. semiconductor industry that had been surpassed by Japanese industry in the mid-1980s. SEMATECH was funded over five years by public subsidies coming from the U.S. Department of Defense via the Defense Advanced Research Projects Agency (DARPA) for a total of $500M. Following a determination by SEMATECH Board of Directors to eliminate matching funds from the U.S. government after 1996, the organization's focus shifted from the U.S. semiconductor industry to the larger international semiconductor industry, abandoning the initial U.S. government initiative. Its members represent about half of the worldwide chip market. By incentivizing and empowering all non-Asian semiconductor manufacturers, the U.S. remained a powerful global player in the semiconductor industry. Today, SEMATECH is reduced to an academic R&D outlet and does not have publically open consortium infrastructure as it did before. SEMATECH hosts and administers more than 12 centers and consortia, including the EUV Resist Test Center, EUV Mask Blank Development Center, EUV Process Development Center, Alternative Lithography Technologies Center, 3D Interconnect Center, Advanced Metrology Center, Universal Nanoelectronics Institute for Technology and Education, and New York Alliance for Advanced Science and Technology. Examples of technical programs include

- 193i: Assess extensibility of immersion beyond 45-nanometer half-pitch, by improving fluids, lens materials, and resists;
- EUV: Prepare EUV infrastructure for insertion at 32-nanometer half-pitch technology generation, using new microexposure and full-field tools at resist test centers and work toward defect-free mask blanks;
- 3D: Pursue wafer-to-wafer and die-to-wafer integration by roadmapping technology options, developing unit processes and metrology, and demonstrating functionality and reliability; and
- Metrology: Focus on the invention, research, development, and application of measurement methods for advanced technologies, with expanded programs in advanced microscopy, and metrology for CMOS and nanotechnology applications.

SEMATECH first took root at CNSE in 2002, with the establishment of a $400M next-generation 300-millimeter R&D center at CNSE's Albany NanoTech complex. To support the program, New York State contributed substantial funding along with SEMATECH and its member companies, including IBM, with initial project research aimed at R&D in the area of advanced lithography infrastructure for extreme ultraviolet (EUV) lithography, which is crucial for computer chip manufacturing technology in the future, because technical advances are expected to cause present-day manufacturing methods to become obsolete for the most advanced chips.

SIGNIFICANCE/SIMILARITIES

SEMATECH is the gold standard of consortia. Although it is not analogous to FGMIC's potential mission, it is the model for NNMIs and beyond to consider.

SUCCESSFUL OUTCOMES

Besides countless semiconductor innovations and patents, the initiative directly resulted in more than $200B in income to the U.S. economy. Industry agrees: “Intel believes it has saved $200M to $300M from improved yields and greater production efficiencies in return for annual SEMATECH investments of about $17M.” SEMATECH has been responsible for many of the largest merges/acquisitions in the world after companies worked together because of solid IP collaboration models.

NOTABLE INDUSTRY PARTNERS/MEMBERS

Original members: AT&T Microelectronics, Advanced Micro Devices, IBM, Digital Equipment, Harris Semiconductor, Hewlett-Packard, Intel, LSI Logic, Micron Technology, Motorola, NCR, National Semiconductor, Rockwell International, and Texas Instruments. International companies (i.e., Samsung, Tokyo Electron, Global Foundries, NXP, etc.) have been members.

MEMBERSHIP/BUSINESS MODEL

Megalarge, complicated amounts of money and infrastructure that is in-kind (i.e., equipment, software, etc,). The original membership model is not easily available.

IP POLICY

See attachments in appendix.

ORGANIZATION TYPE

506(c)1 .

ORIGINAL LEAD(S)

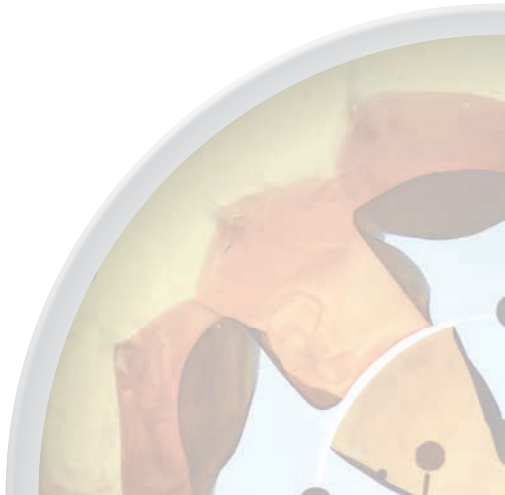
City of Austin, Texas.

HQ/MAJOR LOCATIONS

Austin, Texas, originally, then moved to Albany, N.Y.

NOTES

See number of attachments on development and impact of SEMATECH at
https://web.archive.org/web/20130702191328/http://www.sematech.org/corporate/history.htm



A-3.) National Digital Engineering and Manufacturing Consortium (NDEMC)—http://ndemc.org/

SYNOPSIS

The Consortium was funded by a public–private partnership established by the U.S. government and participating OEMs. The NDEMC's main purpose is to pilot programs that promote adoption and advancement of modeling and simulation (MS&A) and high-performance computing (HPC) among small- and medium-sized manufacturers (SMEs) in the U.S. The network of OEMs, manufacturers, solution providers, and collaborators that make up the NDEMC will result in accelerated innovation through a powerful collaborative ecosystem of like-minded organizations. NDEMC seeks to bring HPC hardware, software, and technical resources to small manufacturers through partnerships with national laboratories and universities. Initiative offers expertise to MS&A software and the hardware necessary to make MS&A work. The project is initially focused in the Midwestern U.S., where an extensive manufacturing base exists and a chance for major economic impact was identified. The Council on Competitiveness and its partners will be working to scale this project into a nationwide network of solution providers and manufacturers leveraging the NDEMC. The EDA and its partners will study the economic impact of technology-based innovation infrastructure toward boosting the long-term job capacity and competitiveness of U.S. manufacturing and industry.

SIGNIFICANCE/SIMILARITIES

Similar to DMDII, this had modeling/simulation projects that may have focused on the glass industry or opportunities already established to do so. Although initial funding is over, the EDA currently is reviewing the outcomes report below to decide if more funding will be provided this consortium.

SUCCESSFUL OUTCOMES

Organizations that use MS&A have consistently seen double-digit increases to productivity, revenue, and employment, see http://ndemc.org/wp-content/uploads/2015/04/NDEMC_Final_Report_04-2015.pdf.

NOTABLE INDUSTRY PARTNERS/MEMBERS

Lockheed Martin, Proctor and Gamble, GE, Boeing, Deere, and NASA Glenn.

MEMBERSHIP/BUSINESS MODEL

No membership. The project started with 18 months of public funds from the Department of Commerce Economic Development Administration (EDA) totaling $2.02M. This investment was matched with $3M in additional funds from private and state sources. Although it is not current or available now, it appears they wanted to sustain funding through training and consulting.

IP POLICY

N/A.

ORGANIZATION TYPE

Does not appear a formal incorporation ever was established.

ORIGINAL LEAD(S)

Council on Competitiveness.

HQ/MAJOR LOCATIONS

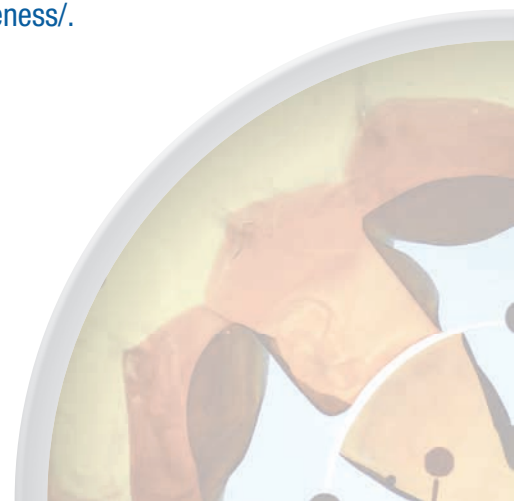
Mostly virtual among the partners, but with physical presence throughout the Midwest and Washington, D.C, (at the Council for Competitiveness headquarters).

HEAD EXEC BACKGROUND

Cynthia McIntyre currently is the senior vice president of the Council on Competitiveness, a nonpartisan, NGO, which is dedicated to developing public policy recommendations to enhance American competitiveness by creating new domestic jobs in the U.S. She has a proven track record of cultivating government and private industry collaborations to create various new technology innovations. McIntyre's responsibilities include leading the High-Performance Computing (HPC) Initiative that involves helping to develop policies to enhance the use of HPC in the private sector for greater economic return and competitive advantage. As a result of these efforts, the Council was asked by the White House in 2010 to create and lead a public–private partnership to help small- and medium-sized manufacturers (SME) in the Midwest to use HPC modeling and simulation, through NDEMC. McIntyre has established herself as a driving force in influencing HPC development. She built the National Digital Engineering and Manufacturing Consortium (NDEMC) while maintaining a senior role for the Council on Competitiveness on top of leading the HPC Initiative. It will be interesting to see how she tops her achievements gained from the previous year. Prior to arriving to the Council, McIntyre was chief of staff to the president of Rensselaer Polytechnic Institute from 1999 to 2007. In this capacity, she had executive oversight and management of three areas in the Office of the President—one of which was Intellectual Property, Technology Transfer, and New Ventures—and grew licensing revenue from $45K to $1.2M in five years. She was a member of the Board of Trustees for Spelman College (2003 to 2009); is on the External Advisory Committee of the National High Magnetic Field Laboratory, Florida State University (2005 to present); and was a member of the Governing Board of the American Physical Society (1998 to 2000). McIntyre is a theoretical condensed-matter physicist and holds a Ph.D. in physics from the Massachusetts Institute of Technology. She was a Bunting Fellow at Harvard University. Once removed from the confines of her office, she is an avid jazz enthusiast and supporter of the fine arts. The North Sea Jazz Festival is one of her favorite destination spots for great live jazz performances.

NOTES

Seems to have graduated the program to DMDII, see http://www.compete.org/news/all/2605-council-led-ndemc-inc-lands-important-role-in-next-gen-digital-manufacturing-institute, http://www.enterprisetech.com/2012/11/19/ndemc_update_program_to_bring_hpc_advanced_manufacturing_technology_to_midwestern_companies_now_underway/, and
http://www.enterprisetech.com/2011/10/03/what_s_the_latest_on_ndemc_a_conversation_with_the_council_on_competitiveness/.



A-4.) Materials Genome Initiative—https://www.mgi.gov/

SYNOPSIS

The Materials Genome Initiative is a multiagency initiative designed to create a new era of policy, resources, and infrastructure that support U.S. institutions in the effort to discover, manufacture, and deploy advanced materials twice as fast, at a fraction of the cost. Advanced materials are essential to economic security and human well being, with applications in industries aimed at addressing challenges in clean energy, national security, and human welfare, yet it can take 20 or more years to move a material after initial discovery to the market. Accelerating the pace of discovery and deployment of advanced material systems will, therefore, be crucial to achieving worldwide competitiveness in the 21st century. Since the launch of MGI in 2011, the federal government has invested more than $250M in new R&D and innovation infrastructure to anchor the use of advanced materials in existing and emerging industrial sectors in the U.S.

SIGNIFICANCE/SIMILARITIES

Although this is not a consortium, these efforts overlap nicely with the materials and simulation/modeling objectives outlined by the FGMIC roadmap.

SUCCESSFUL OUTCOMES

One of its many initiatives—specifically under its High-Throughput (Combinatorial) "Foundry" for Inorganic Materials: "Data on Demand"—has simulation and experimental outcomes that already benefit some areas of functional glass, most notably, materials for thermochromic smart windows, see https://mgi.nist.gov/high-throughput-combinatorial-foundry-inorganic-materials-data-demand. It also has done extensive research in the development of electronic materials, again, where functional glass has a few examples, see https://mgi.nist.gov/genomics-electronic-materials.

NOTABLE INDUSTRY PARTNERS/MEMBERS

Almost no industry is involved.

MEMBERSHIP/BUSINESS MODEL

None, this is a government effort which is free, not paid for by users.

IP POLICY

No IP, all research and open data sourcing.

ORGANIZATION TYPE

None, not incorporated. None, not incorporated.

ORIGINAL LEAD(S)

White House.

HQ/MAJOR LOCATIONS

Virtual, no physical headquarters, but hosted out of Washington, D.C., and other federal agencies (i.e., NIST).

HEAD EXEC BACKGROUND

Cyrus Wadia, White House Office of Science and Technology Policy Advisor, see http://www.cyruswadia.com/prof/Home.html.

NOTES

See https://www.mgi.gov/content/materials-project, https://www.mgi.gov/content/center-theoretical-and-computational-materials-science-ctcms, https://www.mgi.gov/national-objectives/infrastructure-and-consumer-goods***, https://www.mgi.gov/strategic-goals/facilitate-access-materials-data, and https://mgi.nist.gov/.

A-5.) National Robotics Initiative (Several agencies, seems spearheaded by NSF)—https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503641

SYNOPSIS

NRI seems to be a significant funding/grant program for R&D. The goal of NRI is to support fundamental research that will accelerate the development and use of robots in the U.S. that work beside or cooperatively with people. The original NRI program focused on innovative robotics research that emphasized the realization of collaborative robots (corobots) working in symbiotic relationships with human partners. The NRI-2.0 program significantly extends this theme to focus on issues of scalability: how teams of multiple robots and multiple humans can interact and collaborate effectively; how robots can be designed to facilitate achievement of a variety of tasks in a variety of environments, with minimal modification to the hardware and software; how robots can learn to perform more effectively and efficiently, using large pools of information from the cloud, other robots, and people; and how the design of the robots' hardware and software can facilitate large-scale, reliable operation. In addition, the program supports innovative approaches to establish and infuse robotics into educational curricula, advance the robotics workforce through education pathways, and explore the social, behavioral, and economic implications of our future with ubiquitous collaborative robots. Collaboration between academic, industry, nonprofit, and other organizations is encouraged to establish better linkages between fundamental science and engineering and technology development, deployment, and use. Well-justified international collaborations that add significant value to the proposed research and education activities also will be considered.

SIGNIFICANCE/SIMILARITIES

Again, with such a vast program, several applications are under this initiative with several efforts that either directly impact the glass manufacturing industry or could align with it

SUCCESSFUL OUTCOMES

In 2013, NSF, in partnership with NIH, USDA, and NASA, announced new investments totaling approximately $38M for the development and use of robots that cooperatively work with people to enhance individual human capabilities, performance, and safety. In 2012, $50M in this initiative was awarded to projects. Pertinent manufacturing robotics projects include the following.

- Collaborative Research: Multilateral Manipulation by Human–Robot Collaborative Systems (all academic partners). This project seeks to emulate the expert–apprentice relationship using humans and robots. It focuses on developing ways in which robots can learn from human activity to help humans by providing more hands, eyes, and brain power as necessary, enabling multilateral manipulation from multiple vantage points. Applications in the manufacturing plant or in the operating room are potentially numerous.
- The Intelligent Workcell: Enabling Robots and People to Work Together Safely in Manufacturing Environments (academic). This research will develop an intelligent workcell to enable people and industrial robots to work safely and more efficiently within the same workspace. New capabilities in robotic workcell monitoring likely will result. Smart work environments know where you are and what you need, and what you are doing to avoid hindrance and to support assistance.
- This project addresses a large space of manipulation problems that are repetitive, injury-causing, or dangerous for humans to perform, yet currently are impossible to reliably achieve with purely autonomous robots. These problems generally require dexterity, complex perception, and complex physical

interaction. Yet, many such problems can be addressed reliably with human–robot collaborative (HRC) systems, where one or more humans provide needed perception and adaptability, working with one or more robot systems that provide speed, precision, accuracy, and dexterity at an appropriate scale, combining these complementary capabilities. The project focuses on multilateral manipulation, which occurs when a human controls one or more robot manipulators in partnership with one or more additional controllers (humans or autonomous agents). Complex operations in surgery and manufacturing can benefit from the extra degrees of freedom provided by more than two hands, and training often depends on hands-on interaction between expert and apprentice. Example applications include surgical operations, which typically involve several physicians and assistants, and other medical tasks, such as turning a patient in bed and wrapping a cast to constrain a hand. Multilateral manipulation also applies in manufacturing, for example, for threading wires or cables, aligning gaskets to obtain a tight seal, and in many household situations, such as folding tablecloths, wrapping packages, and zipping overfilled suitcases so they will fit inside diabolically designed overhead airline compartments. Multilateral manipulation often occurs with deformable materials or multijointed objects with more than six degrees of freedom (DOF). The extra DOFs in materials introduce challenges, such as computational complexity, but they also can accommodate minor inconsistencies through redundancy and provide system damping. This project advances the fundamental science of multilateral manipulation guided by specific applications from surgery and manufacturing. Broader impacts include multilateral manipulation systems that have the potential to improve healthcare, improve American competitiveness and product quality in manufacturing, and open the door to new service robot applications in the home. The project will be guided by an advisory board of experts from industry and medical practice. Project results will be disseminated through yearly conference workshops, open-source software tools integrated into common robotics software environments, such as robot operating system (ROS), and the investigators' research and course webpages, to encourage integration of this approach into research projects and courses at many institutions. Outreach programs, public laboratory tours, and mentoring of minority students will broaden participation of underrepresented groups in engineering. These activities will encourage participation in STEM activities and provide student and postdoctoral researchers with mentoring experience.

- NRI Small Collaborative Research: Adaptive Motion Planning and Decision-Making for Human–Robot Collaboration in Manufacturing. This project addresses manufacturing tasks that cannot be fully automated because of either the limitations of current algorithms or prohibitive cost and set-up time. Such tasks generally require workers to collaborate in close proximity and adapt to each other's decisions and motions. This project explores accomplishing these tasks through human–robot collaboration. Recent hardware developments in robotics have made human–robot collaboration physically possible, but robots continue to require new algorithms to ensure safety, efficiency, and fluency when working with people. Creating such algorithms is difficult, because there can be high uncertainty in what people are going to do and how they are going to do it. This project explores the integration of reasoning about how people move and how they make decisions into a robot motion-planning and decision-making framework. The research centers on the development of new algorithmic frameworks for modeling, simulating, and planning for human–robot collaboration, which requires advances in robot training, task modeling, human motion understanding, high-dimensional motion planning with uncertainty, and metrics to assess human–robot joint action. The results of this project have the potential to significantly improve American competitiveness in manufacturing, especially for small-batch manufacturing and burst production, where the cost and set-up time of fully autonomous solutions is prohibitive. The work will be disseminated in research papers and integrated into curricula. The project is guided by an advisory board from the manufacturing industry, which provides another avenue for dissemination.
- Dexterous manipulation is a grand challenge in robotics today. Dexterity is required for robots working in the home, in space, for medical applications, under disaster scenarios, and in flexible manufacturing. Robots in these environments must be able to maneuver, lift, and handle objects; use them as tools; and competently transfer objects from one secure hold to another in a wide variety of uncertain situations. Such operations are very difficult for robots and present a barrier to their wider adoption. Recent advances in rapid prototyping and digital manufacturing have made it possible to design,

manufacture, and test custom robot manipulators at a very rapid pace. One aim of this project is to explore and understand how these new technologies may be used to design a radically different type of robot manipulator that is customized for dexterous maneuvers. Another aim of the project is to increase fundamental understanding of dexterity itself. The end goal is to enable robots to live up to their potential. In so doing, robots will begin to play an increasingly important role in daily lives and will inspire young students to prepare for and pursue STEM careers. The key research goal of this project is to formalize novel mathematical models and computational approaches to codesign mechanical structures and control policies for dexterous robotic manipulation tasks. Through this approach, control policies can be made significantly simpler, and mechanical features, such as joint stops and compliance, can passively improve the robustness of the manipulation tasks while reducing sensing and actuation requirements. Grasp nets, which capture specific families of manipulation capabilities observed in human performances, focus the efforts of this project and guide the design processes that are developed.

- Tactile sensing is ubiquitous in nature, arguably even more essential than vision. Most animals have thousands of cutaneous sensors over their bodies for touch, temperature, etc. However, even the most sophisticated robots have relatively few tactile sensors and, after 30 years of research, tactile sensing lags behind computer vision. This project aims at the development of a novel artificial skin mimicking the human skin that can be fitted into any robotic hand providing information-rich sense of touch. This technology leads to the development of extremely sensitive robotic skins with unprecedented tactile sensing capabilities. As such, this work enables a plethora of robotic applications where tactile sensing is of utmost importance, ranging from robotic caregivers to medical robotics and autonomous exploration. The methodology in this project may revolutionize the way future robots are designed, enabling their broad applicability. This effort represents a major milestone in endowing robots with the sensory information required to conduct tasks in human-centered environments. The advent of microprocessors for touch sensing, spurred by the smart-phone industry, has helped to address the wiring problem with local processing of information and communication. However, there remain the critical problems of fabricating a multifunctional artificial skin that can conformally cover arbitrary surfaces, diagnose in real-time the contact state, and gather a large amount of data for high-resolution tactile sensing, while minimizing power consumption. Overall, this effort addresses tactile sensing from a system-level point of view. The approach involves the development of advanced manufacturing technologies from leveraging nonstandard CMOS/MEMS/NEMS fabrication processes to produce a low-cost and robust artificial skin outfitted with multimodal microsensors. The tactile sense of touch is achieved via an innovative microcontact sensing technique based on ultrasound waves generated from embedded sensors to identify local contact/slip conditions. Finally, the validation and performance evaluation is demonstrated through a series of graded tactile sensing experiments.
- NRI, Human Cognition-Assisted Control of Industrial Robots for Manufacturing. Advanced manufacturing, driven by industrial robots, is playing an increasing role in the U.S. economy. Robots are being used to conduct assembly, welding, material handling, and fabrication. Even as such interactions are becoming more common in every phase of manufacturing, a perfect symbiotic relationship between machines and humans remains very far away. Therefore, a majority of the robotic applications in manufacturing currently are limited to areas where a relatively low level of skill is required. This has restricted the full potential of robotics to augment human operators and improve productivity and quality of life. With recent advances in cognitive neuroscience and brain interface technologies, connecting the human cognitive thought process directly to robots and machines is possible, resulting in direct control of real-world applications. By collecting the brain signals using sensors and analyzing the thought processes, many activities that take place inside the brain when humans take specific actions or think of actions can be identified and matched to known signals using fast computation. This new human–robot communication paradigm will be demonstrated by developing three manufacturing scenarios. Results from this multidisciplinary research, which combines manufacturing, computer science, and robotics, have the potential to improve the productivity of future manufacturing plants and can lead to new commercial ventures, which will help the U.S. maintain worldwide leadership in robotics and manufacturing, broaden participation of underrepresented

groups in research, and positively impact engineering education. Significant future challenges in the development of a new human–robot communication system, which allows operators to perform complex high-skilled tasks, will be addressed. The postulated paradigm will be explored by meeting the following intellectual challenges: researching a novel methodology for communicating motion commands to a robot by imagining simple actions using a grammar called actemes; new brain-computer mode and algorithms to classify these actemes; and an intent-based system that auto-completes robotic actions based on most likely sequence of events that human operators are planning to complete. Three robotic manufacturing scenarios will be explored to demonstrate the human-cognition-based interactions in manufacturing environment: assembly, direct control, and quality control through object recognition. Finally, using a noninvasive brain-computer interface, a wide range of day-to-day applications of robotics will be demonstrated.

Additional manufacturing robotics projects that may/may not be relevant to the glass industry include those improving robotic grasp and high-precision manipulation via managing uncertainty in human–robot cooperative systems.

NOTABLE INDUSTRY PARTNERS/MEMBERS

No industry partners have been engaged.

MEMBERSHIP/BUSINESS MODEL

Again, not a consortium model.

IP POLICY

N/A.

ORGANIZATION TYPE

Not incorporated.

ORIGINAL LEAD(S)

N/A.

HQ/MAJOR LOCATIONS

Mostly operated from NSF, but NIH, NASA, and USDA are involved.

HEAD EXEC BACKGROUND

N/A.

NOTES

See http://www.roboticscaucus.org/.

A-6.) National Center for Manufacturing Sciences—http://www.ncms.org/

SYNOPSIS

NCMS connects industry, government, and education to work together on technology development and engage in unique growth opportunities for their businesses. NCMS is the nation's largest cross-industry technology development organization, dedicated to improving the competitiveness and strength of the U.S. industrial base. As a member-based consortium, NCMS leverages its network of members and partners to research, develop, demonstrate, and transition innovative technologies more efficiently, with less risk, and at a lower cost than going it alone. More than 1,000 contracts have been executed among partners, worth $840M. A majority of the contracts have been funded by DOD. NCMS was formed in 1986 to strengthen North American manufacturers and respond to global competition. The balance between long-standing experience and fresh innovation requires a unique intersection of highly capable companies, access to efficient, effective contracting vehicles and relationships built on credibility and trust. Through NCMS, companies with innovative technologies can collaborate with end users and develop solutions to meet their requirements. NCMS has long-established relationships, a stellar reputation, and credibility among federal agencies end users. NCMS couples its collaborative power to partner small R&D companies with top tier OEMs. The results are innovations and opportunities to develop and refine and provide user-centric solutions. Technology pillars constantly assessed and developed include additive manufacturing, advanced materials/composites, automation, cyber security, digital manufacturing, and robotics/AVs.

SIGNIFICANCE/SIMILARITIES

This is a manufacturing centric organization with dues. It is very straight forward in its approach. It has successfully deployed R&D and manufacturing testbed/demonstration projects in many sectors. It also has deep respect from industry.

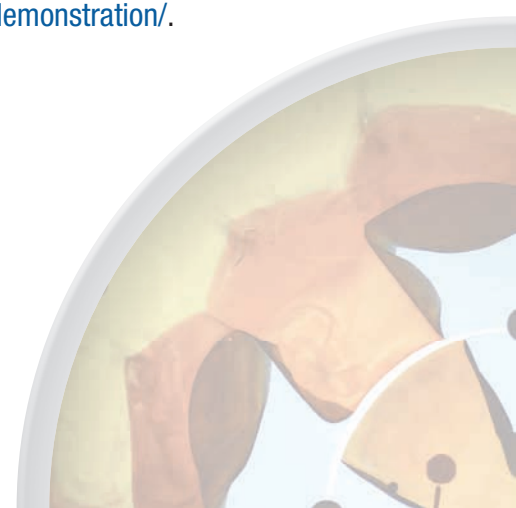
SUCCESSFUL OUTCOMES

NCMS has generated consortia and/or other plausible outcomes for U.S. manufacturing, although most have become hosted by the federal government (i.e., DOD, such as the Robotics Technology Consortium). See http://www.ncms.org/about/timeline/, http://www.ncms.org/category/robotics-technology-consortium/, and http://www.acq.osd.mil/sts/docs/factsheet-robotics_technology_consortium.pdf.

Particular glass projects, including safety glass improvements at http://www.ncms.org/enhanced-environmental-performance-safety-glass-phase-ii/ and turbine nozzle glassification at http://www.ncms.org/t700-first-stage-turbine-nozzle-sandsalt-phobic-treatment-concept-demonstration/.

NOTABLE INDUSTRY PARTNERS/MEMBERS

GE, Eclypse, Dassault, Siemens PLC, and many others on specific projects.



MEMBERSHIP/BUSINESS MODEL

Tiered membership based on annual income/revenues.

IP POLICY

NCMS has used a majority policy to build several consortia over the years, and some of the models have varied. An inventor-owns model is recommended for the consortia. In such an arrangement, companies can retain their early advantage in the marketplace and drive faster implementation. Background IP contributed to the project and to project participants and third parties is solely at the discretion of the owner and under conditions established by the owner. At the same time, title to foreground IP vests in the developer/inventor, who pays for patent, copyright, trademark, and other legal protection. Project participants receive nonexclusive, royalty-free licenses to foreground IP, and participants can sublicense IP they develop, but not IP developed by other participants (Notwithstanding the above, participants may sublicense foreground IP to wholly- and majority-owned subsidiaries.) Royalties generated stay with the licensing party. The government receives government purpose license rights as appropriate.

ORGANIZATION TYPE

501(c)3.

ORIGINAL LEAD(S)

N/A.

HQ/MAJOR LOCATIONS

Ann Arbor, Mich.

HEAD EXEC BACKGROUND

Rick Jarman is the president & CEO of NCMS, located in Ann Arbor, Mich. NCMS is the largest cross-industry collaborative manufacturing research consortium in the U.S. devoted exclusively to manufacturing technologies, process, and practices. NCMS was formed in 1986, and its mission is focused on the development of strategic initiatives and programs aimed at sustaining and enhancing the global competitiveness of North American manufacturing. Prior to his position at NCMS, Jarman was director of technology partnerships at Eastman Kodak Co. He was a driving force to forge alliances with industry and government to improve commercialization processes through innovation and new technology. Jarman was responsible for managing these global relationships and programs with policy makers, partners, and consortia management to leverage these synergistic, strategic partnerships. Jarman serves on several industry boards and advisory groups related to his work in building collaborative alliances. He is the coauthor of the book *Collaborative R&D: Manufacturing's New Tool*, published by John Wiley & Sons (New York) in April 1999. In 2001, working with management from several major corporations, including Kodak, and elected officials in federal, state, and local offices, he cofounded the Infotonics Technology Center in upstate New York. The goal of the Center was to establish a unique, world-class R&D center in the area of photonics and related microsystems. In support of this endeavor, a state-of-the-art prototype and pilot fabrication facility was built to enable innovation and the rapid commercialization of new products. In 1978, Jarman joined Eastman Kodak Co. Business Systems Markets Division, where he held advancing roles in field and staff marketing and management positions. In 1986, he was appointed executive agency manager in Washington, D.C. This position was established to integrate the strategic planning and markets development for the federal government market. In 1988, he was selected to represent Kodak on the President's Commission on Executive Exchange. During the year, he participated in the Commission's program at Harvard University examining the roles of private industry and government. He played a key role on the trade committee during the Commission's meetings in the USSR and Western Europe. Issues discussed included U.S./USSR joint ventures and the European Community plans for 1992. For the remainder of 1988, Jarman served as special assistant to the Assistant Secretary of Defense for Production and Logistics in the Pentagon. Here he provided executive counsel on issues, such as total quality management and bolstering the defense industrial base. When he returned to Kodak, Jarman was named director of international planning for the Business Imaging Systems Division. In this role, he developed alternative business strategies for Europe and provided analysis of competitors and potential alliances for marketing, manufacturing, and design in Europe and Asia. Jarman holds a degree in business administration from Bloomsburg University.

NOTES

NCMS is very DOD focused, but not all topics are defense related. However, they all are, in some way, tied to manufacturing and logistics. See a sample project at http://www.ncms.org/wireless-command-control-system-wccs-for-material-handling-equipment-mhe-installation-at-defense-logistics-agency/.

A-7.) National Materials and Manufacturing Board—http://sites.nationalacademies.org/DEPS/NMMB/index.htm

SYNOPSIS

In recognition of the increasing importance of materials science to innovations in engineering and manufacturing, the new National Materials and Manufacturing Board (NMMB) combines the charges of two preexisting boards: the National Materials Advisory Board and the Board on Manufacturing and Engineering Design. The mission of this new body is to build on the past achievements of its parent boards by providing objective, independent assessments of the current state of materials and manufacturing research, including at the atomic, molecular, and nano scales, and the applications of new and existing materials in innovative ways, including pilot-scale and large-scale manufacturing, the design of new devices, and disposal. Previous studies by NMMB's predecessors have covered a diversity of timely, consequential topics, including global supply chains and national security, real-time detection of damage to materials in aerospace applications and of threat agents, integrated computational materials engineering, and management of existing U.S. materials resources. Under the sponsorship of U.S. government agencies, such as the Department of Defense, Department of Energy, Department of Commerce, Department of Transportation, and National Science Foundation, NMMB will be responsible for the strategic planning, program development, and administrative oversight of studies and other activities that expand this existing body of work.

SIGNIFICANCE/SIMILARITIES

Not a consortium, but definitely a driving force of research on materials and their manufacturing.

SUCCESSFUL OUTCOMES

Too early to note, but NMMB has some outcomes for biomedical materials and nanomaterials. There is nothing specific in manufacturing as yet.

NOTABLE INDUSTRY PARTNERS/MEMBERS

IBM, SRC, Boeing, and mostly academia/national orgizations.

MEMBERSHIP/BUSINESS MODEL

Not incorporated, no membership.

IP POLICY

None, seems to be open policy.

ORGANIZATION TYPE

Division of the National Academies of Sciences, Engineering, and Medicine.

ORIGINAL LEAD(S)

The National Academies of Sciences, Engineering, and Medicine.

HQ/MAJOR LOCATIONS

Washington, D.C.

HEAD EXEC BACKGROUND

James Lancaster, director, appears to have received his Ph.D. from Rice University in astrophysics and made a career at the National Academies.

A-8.) National Center for Defense Manufacturing and Machining—http://www.ncdmm.org/

SYNOPSIS

Founded in 2003, NCDMM's mission is to promote the use of cost-effective manufacturing solutions by current and future U.S.-based producers of Department of Defense (DOD) systems by assisting with the ongoing identification and implementation of, and transition to, state-of-the-art manufacturing and technology solutions. NCDMM works closely with all DOD organizations and DOD suppliers to identify opportunities where process improvements will lead to significant cost savings or removal of critical bottlenecks. Its in-house manufacturing experts, along with a vast network of Alliance Partners and Manufacturing Consortium, develop and transition to the shop floor improved manufacturing and machining technologies and methodologies. To date, NCDMM projects have generated more than $500M in cost savings or avoidance for the DOD and its supply base. NCDMM takes great pride in reducing manufacturing and machining costs, enabling more critical hardware and supplies to be available for troops in defense of the nation. NCDMM works on program management, manufacturing engineering, design engineering, assessments, and supply chain management. Besides conferences, it currently runs America Makes, MRSI, and MT Connect Institute, all manufacturing initiatives.

SIGNIFICANCE/SIMILARITIES

NCDMM is a very strong, respected organization that should be studied and mimicked. The President learned much from the America Makes initiative.

SUCCESSFUL OUTCOMES

Many industry and government successes, mostly in automation, see http://www.ncdmm.org/stories/.

NOTABLE INDUSTRY PARTNERS/MEMBERS

Major DOD branches. Corporate N/A, most interacted with the consortium on singular projects.

MEMBERSHIP/BUSINESS MODEL

N/A and now seems to push membership in America Makes NNMI.

IP POLICY

Does not appear to be a consortium itself.

ORGANIZATION TYPE

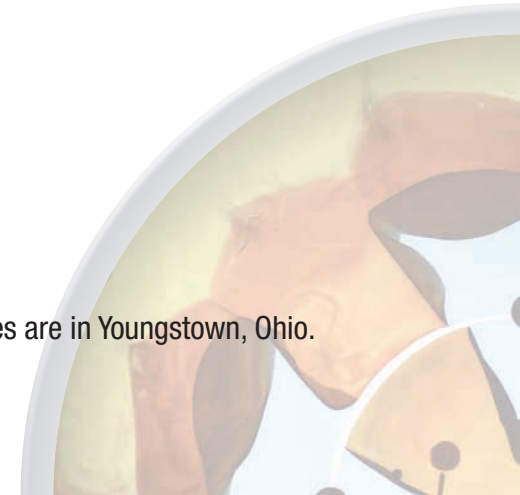
501(c)3.

ORIGINAL LEAD(S)

NCDMM is its own entity.

HQ/MAJOR LOCATIONS

Headquarters is a brick and mortar facility in Blairsville, Pa. There also are facilities in Chambersburg, Pa. America Makes offices are in Youngstown, Ohio.



HEAD EXEC BACKGROUND

Ralph Resnick, president and executive director (also founded America Makes) is widely known throughout the manufacturing industry as a visionary. With Resnick at the helm of NCDMM, its staff, customers, and partners benefit from the unique point of view afforded by his 30+ years of experience. Today, he continues to guide and drive collaborative and advanced manufacturing solutions industry-wide. Resnick became NCDMM's third president and executive director in May 2011 after serving three years as its vice president, chief technology officer, and director of corporate development. His keen understanding of the potential of public–private partnerships proved invaluable as he led NCDMM to win the competitive contract in 2012 to establish America Makes, National Additive Manufacturing Innovation Institute, pilot institute for Manufacturing USA, and National Network of Manufacturing Innovation. He also assumed the role of acting director of the Institute until February 2013 upon appointment of a new director. Prior to joining NCDMM, Resnick served as chief technology officer for the ExOne Co. and Extrude Hone Corp., where he was a major contributor in establishing both organizations as leaders in advanced manufacturing, including such areas as additive manufacturing, process research, and technology transition to the world's factory floors. Resnick is a Fellow of SME and chair of SME's International Awards and Recognition Committee. He serves on numerous national and local boards.

A-9.) Composites Design and Manufacturing HUB—https://cdmhub.org

SYNOPSIS

The Composites Design and Manufacturing HUB (cdmHUB) is a collaborative web interface platform designed to enhance and build synergies among the composites community by enabling users to interact 24 hours a day, seven days a week. The platform was developed to host the simulation tools needed to advance composite materials design, certify product integrity, simulate manufacturing solutions, and accelerate the talent base of composite materials developers and users. cdmHUB will showcase emerging simulation tools, evaluate existing and emerging simulation tools, and host simulation challenges to educate and unify the composites community. This web site is a resource for research, education, and collaboration in the composites field. It hosts various resources that will help users learn about composites design and manufacturing, including online presentations, courses, learning modules, animations, and teaching materials. These resources come from contributors in the composites community and are used by visitors worldwide. Most importantly, cdmHUB.org offers simulation tools that users can access from their web browser. Therefore, they can learn about and simulate the composites design and manufacturing process. An article by R.B. Pipes in the June 2014 issue of Composites Manufacturing Magazine further introduces cdmHUB.

SIGNIFICANCE/SIMILARITIES

Interesting, miniconsortia model that is virtual. Also, it focuses on modeling/simulation of composite materials.

SUCCESSFUL OUTCOMES

N/A.

NOTABLE INDUSTRY PARTNERS/MEMBERS

Unknown, because it is free/accessible to anyone.

MEMBERSHIP/BUSINESS MODEL

There appears to be none. It is a free resource, but community members can contribute programming and/or concepts.

IP POLICY

N/A.

ORGANIZATION TYPE

Not incorporated.

ORIGINAL LEAD(S)

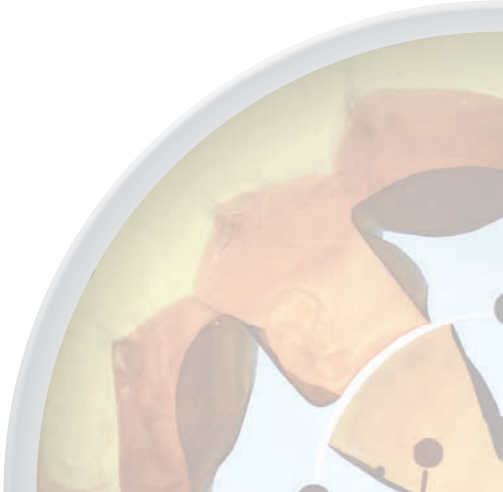
Purdue University, West Lafayette, Ind.

HQ/MAJOR LOCATIONS

Entirely virtual, no physical location.

HEAD EXEC BACKGROUND

R. Byron Pipes was elected to the National Academy of Engineering in 1987 in recognition of his development of an exemplary model for relationships between corporate, academic, and government sectors to foster research and education in the field of composite materials. As cofounder and director of the Center for Composite Materials at the University of Delaware (Newark, Del.), he developed an industrial consortium of more than 40 corporate sponsors from the U.S., Japan, Germany, France, Italy, United Kingdom, Belgium, Sweden, and Finland. Today, almost 40 years after its founding, the University of Delaware Center is the largest and most successful of its type in the U.S. Research expenditures have exceeded $100M. Pipes developed the Composites Design and Manufacturing HUB (cdmHUB) to meet the simulation needs of the growing composites industry in 2013. To date, cdmHUB is supported by five corporate sponsors (Boeing, Rolls Royce, Cytec, Dassault Systemes, and Henkel) and DARPA. His most recent research programs focus on the development of composites manufacturing with emphasis on additive manufacturing. He currently leads the Indiana Center of Excellence of the DOE Institute for Advanced Composites Manufacturing Innovation (IACMI), chairs the Technology Advisory Board, and serves on the Board of Directors of IACMI. His center occupied the Indiana Manufacturing Institute in the Purdue Research Park in 2016. He has active programs in the study of the advanced manufacturing science for composite materials.



A-10.) Ohio Aerospace Institute—http://www.oai.org/

SYNOPSIS

OAI supports aerospace competitiveness through research and technology development, workforce preparedness, and engagement with global networks for innovation and advocacy. OAI conducts sponsored research as well as developing and managing research and technology partnerships that leverage collaboration among industry, universities, and federal laboratories. Besides extensive R&D, especially precompetitive projects, it offers education and networking events.

SIGNIFICANCE/SIMILARITIES

OAI is based in Ohio. It knows how to build multiparty technology development, education, and advocacy programs around a sector. OAI excels at forming pre-competitive consortia designed to address common objectives shared by multiple organizations, including organizations that are competitors in the marketplace. Typically, participating organizations contribute resources that are pooled to fund research of a common interest to all participants—and all participants share in and benefit from the results.

SUCCESSFUL OUTCOMES

OAI has approximately 80 employees and more than $16M in annual revenue. OAI successfully developed a number of functional multiparty team efforts, including

- Aeroacoustics Research Consortium (AARC);
- Polymer-Matrix Composites for VAATE Applications;
- Propulsion Instrumentation Working Group (PIWG); and
- Advanced Manufacturing Technology Consortium for Aerospace (AMTCA).

NOTABLE INDUSTRY PARTNERS/MEMBERS

Air Force Research Laboratory, NASA Glenn Research Center, GE Aviation, Parker Hannifin, Boeing, Goodrich, Lockheed, Timken, Case Western Reserve University, Cleveland State University, Air Force Institute of Technology, The Ohio State University, Ohio University, The University of Akron, University of Cincinnati, University of Dayton, The University of Toledo, and Wright State University.

MEMBERSHIP/BUSINESS MODEL

Top tier companies, $11,000 annual dues and middle tier companies, $ 6,000 annual dues. OAI has revenue from industry-sponsored research fundraising and awarded government contract funding to deliver products and services.

IP POLICY

It appears that participating entities jointly develop and own IP. A list of established technologies OAI was responsible for developing is found at http://www.oai.org/research/technology/.

ORGANIZATION TYPE

501(c)3.

ORIGINAL LEAD(S)

OAI is a joint initiative of the NASA Glenn Research Center, Air Force Research Laboratory at Wright-Patterson Air Force Base, State of Ohio, 10 Ohio public and private universities granting doctoral degrees in aerospace-related engineering disciplines, and numerous companies engaged in aerospace activities.

HQ/MAJOR LOCATIONS

Ohio, USA.

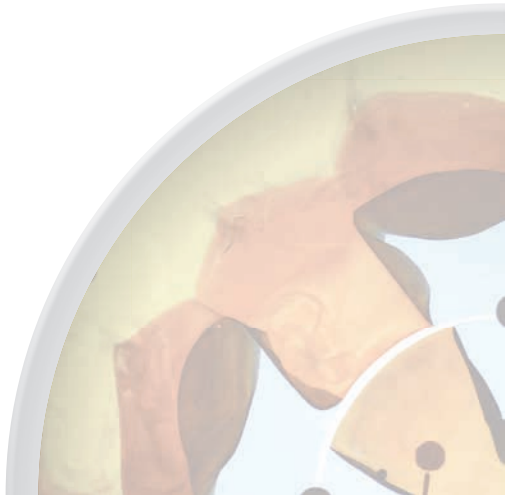
HEAD EXEC BACKGROUND

CEO Jeff Rolf comes to OAI following a distinguished career with Parker Hannifin Corp., where he most recently served as Parker Aerospace's vice president of commercial airframes, business development. He is extensively involved in Ohio's aerospace community, having served as chair and current industry member of the Ohio Aerospace and Aviation Council. He is a charter member of the Ohio Legislature's Ohio Aerospace and Aviation Technology Committee. He holds a B.S. in mechanical engineering, is a professional engineer in Ohio, and holds two U.S. patents.

NOTES

List of R&D projects at http://www.oai.org/research/teams/index.html?sc=3. Complete member list at http://www.oai.org/working/members/index.html.

In addition to the above specific organizations/initiatives, many states are building technology- or sector-specific manufacturing hubs—physical facilities and assets—to further U.S.-based manufacturing. Although we found none with a focus on glass, this is becoming a popular model for a variety of industries to generate new products/markets.



C.) Draft Roadmap Task Force Report and Resource Guide

Besides programs outlined above in this report, there are additional initiatives that may be pertinent resources or direct opportunities for these objectives included below, listed by each FGMIC Roadmap objective as well. Only U.S.-headquartered assets (or those that explicitly state they will work with international entities if not in the U.S.) are highlighted to better align with those organizations' missions and scopes, although perhaps working with other international assets listed in this report could be beneficial partnerships as well. Finally, assets listed above and below are those still seemingly active and in business to date.

Technical Objectives Resources

ROADMAP SENSOR TECHNOLOGY OBJECTIVES

- Solicit industry interest to define key systems that require online, 3-D sensor development.
- Develop more or better sensors to measure data in situ in tanks.
- Develop standardized in situ measurement techniques.
- Characterize melt structure, thermophysical properties, and functionality-specific properties.
- Develop infrastructure for assessing metadata, including measurement techniques and the degree to which the data has been vetted or modeled.
- Develop "smart" refractories with in situ sensors.
- Establish a high-temperature measurement facility to develop awareness of instruments and methodology for measuring industrially important high-temperature properties and to provide industry with opportunities to measure and test physical properties of molten glass.

There are sensors R&D and technology consortium efforts currently in operation that already are in place to work with other industry/research parties on industry-relevant projects. These organizations include

i.) Smart Manufacturing Leadership Coalition/NNMI—CESMII, a recently awarded NNMI assisting with the convergence of sensors, big data analytics, etc., for more efficient, smarter manufacturing processes. Glass is a U.S. DOE-funded sector of interest in its NNMI.
https://www.smartmanufacturingcoalition.org/

Contact: Julie Tran
Email: julie@oit.ucla.edu
Phone: 310-206-6532

ii.) NSF's MIST Center, an NSF-funded University–Industry consortium for the development of advanced sensor technologies.
http://www.mist-center.org/

Contact: Toshi Nishida
Email: nishida@ufl.edu
Phone: 352-392-6774

iii.) Glass Manufacturing Industry Council already has hosted extensive R&D projects in sensors development for furnace and in situ measurements in harsh

environments with notable large industrial partners (i.e., Libbey), small sensors companies (i.e., PaneraTech), and universities (i.e., Ohio State University).
http://gmic.org/

Contact: Bob Lipetz
Email: rwlipetz@gmic.org
Phone: 614-818-9423

iv.) GlassTrend already has funded and has large industrial support for precompetitive topics in all areas of glass manufacturing, including sensor development.
http://www.glasstrend.nl/about-GlassTrend.php

Contact: Elize Harmelink
Email: glasstrend@celsian.nl
Phone: +31 (0) 402 490 100 (Netherlands)

REFRACTORIES OBJECTIVES

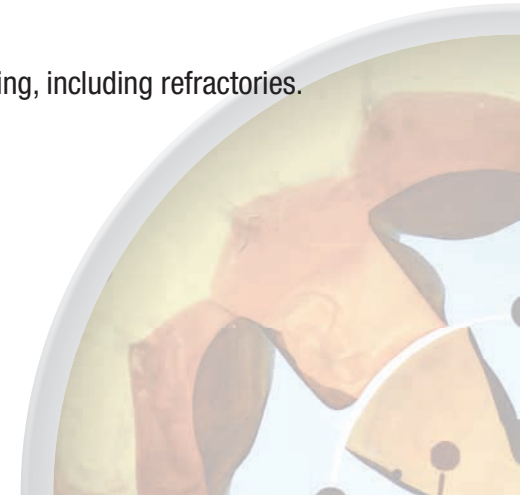
- Increase availability of refractories (i.e., reduce current long lead times).

There are at least two organizations working on refractories, with several universities also pursuing these materials. Finally, GMIC likely will have industry already participating with the subject.

i.) The Refractories Institute (TRI) has a long tradition of providing support and services to manufacturers of refractory materials and products and suppliers of raw materials, equipment, and services to the refractories industry.
http://www.refractoriesinstitute.org/
Contact: ACerS has up-to-date contact

ii.) Society of Glass Technology has conducted extensive research in refractories.
http://www.sgt.org/SGT/AbouttheSGT.html
Contact: Neil Simpson
Email: neilsimpsonfsgt@btinternet.com
Phone: 0114 2634455 (Based in UK)

iii.) GlassTrend already has funded and has large industrial support for precompetitive topics in all areas of glass manufacturing, including refractories.
http://www.glasstrend.nl/about-GlassTrend.php
Contact: Elize Harmelink
Email: glasstrend@celsian.nl
Phone: +31 (0) 402 490 100 (Netherlands)



GLASS STRENGTH OBJECTIVES

- Develop a glass process (e.g., coating) with the ability to improve a final product's mechanical and thermal strength and chemical durability.

i.) Glass Manufacturing Industry Council already has established an industry–research coalition—the Usable Glass Strength Coalition—to study the improvement of glass properties.
http://gmic.org/
Contact: Bob Lipetz
Email: rwlipetz@gmic.org
Phone: 614-818-9423

ii.) GlassTrend already has funded and has large industrial support for precompetitive topics in all areas of glass manufacturing, including glass strength.
http://www.glasstrend.nl/about-GlassTrend.php
Contact: Elize Harmelink
Email: glasstrend@celsian.nl
Phone: +31 (0) 402 490 100 (Netherlands)

iii.) International Partners in Glass Research has conducted several projects with international industry partners, primarily for glass packaging, in increasing glass strength.
https://www.ipgr.com/ipgr-about-us/philosophy.html
Contact: Christian Roos
Email: christian.roos@ipgr.ch
Phone: +41 43 928 2912 (Switzerland)

BATCH-TO-GLASS REACTIONS AND MELT OPERATIONS OBJECTIVES

- Advance understanding of the kinetics of batch-to-glass reactions, including the effects of raw-materials chemistry, grain size, and temperature.
- Designate or develop specialized facilities available to manufacturers for characterizing melts, batch reactions, and fining processes.
- Design and construct an industry–university–government intermediate-sized melt and forming facility.

Assets for research- and industrial-scale melt and/or furnace operations are available at industrial sites as well as research institutions. Contacting these entities to establish potential joint initiatives should be a first step before building new assets.

i.) Bucher-Emhart Glass R&D Center, a complete glass-container production line.
http://old.emhartglass.com/emhart-glass-research-center
Contact: Matthias Kümmerle
Phone: 860-298-7340

ii.) Corning Glass Summit
https://www.corning.com/worldwide/en/innovation/culture-of-innovation/glass-summit-2016.html
Contact: ACerS has up-to-date contact

iii.) Owens-Illinois Innovation Center
http://www.o-i.com/uploadedFiles/Content/Newsroom/Company_brochure_ENU_web_FINAL%20(1).pdf
Contact: ACerS has up-to-date contact

iv.) Gas Technology Institute, a smaller, pilot-scale glass melter.
Contact: David Rue
Email: david.rue@gastechnology.org
Phone: 847-768-0508

v.) GlassTrend already has funded and has large industrial support for precompetitive topics in all areas of glass manufacturing, including furnace/melting processes.
http://www.glasstrend.nl/about-GlassTrend.php
Contact: Elize Harmelink
Email: glasstrend@celsian.nl
Phone: +31 (0) 402 490 100 (Netherlands)

GLASS PRODUCTION TESTING OBJECTIVES

- Identify currently available expressed or accelerated testing methods for screening large sets of glass quickly.

Several commercial entities exist that are well practiced at industrial glass testing and screening.

i.) American Glass Research, as an independent laboratory, is a trusted source to large industrial parties and installs large testing methodologies at plant sites.
www.americanglassresearch.com/
Contact: William Slusser
Email: bslusser@agrintl.com
Phone: (724) 482-2163

ii.) ASTM's C14 Glass and Glass Products Technical Committee. ASTM currently hosts a 141-member committee comprised of industry and research workers that investigates testing methodologies and initiatives within glass production. The committee also has funding and the association's larger Interlaboratory Study Program, which likely can be used to fund this initiative.
https://www.astm.org/COMMIT/C14_Factsheet.pdf
Contact: Tom O'Toole
Email: totoole@astm.org
Phone: 610-832-9739

iii.) Insulating Glass Manufacturing Alliance has a robust R&D initiative and fund that may have already looked into this subject or may have interest in researching with its already existing funding mechanism.
www.igmaonline.org
Contact: Helen Sanders
Phone: (613) 233-1510

GREEN/ENERGY EFFICIENT MELTING PROCESS OBJECTIVES

- Develop more energy-efficient melting processes.
- Explore green manufacturing processes for waste reduction and environmental remediation.

i.) Smart Manufacturing Leadership Coalition/NNMI—CESMII is a recently awarded NNMI that investigates more efficient, greener manufacturing processes. Glass is a U.S. DOE-funded sector of interest in its NNMI.
https://www.smartmanufacturingcoalition.org/
Contact: Julie Tran
Email: julie@oit.ucla.edu
Phone: 310-206-6532

ii.) Gas Technology Institute has research expertise in emissions and waste reduction for melting processes.
Contact: David Rue
Email: david.rue@gastechnology.org
Phone: 847-768-0508

iii.) Glass Manufacturing Industry Council already has hosted R&D projects in energy-efficient melting processes.
http://gmic.org/
Contact: Bob Lipetz
Email: rwlipetz@gmic.org
Phone: 614-818-9423

iv.) International Partners in Glass Research has conducted several projects with international partners, primarily for glass packaging, in making manufacturing processes more efficient.
https://www.ipgr.com/ipgr-about-us/philosophy.html
Contact: Christian Roos
Email: christian.roos@ipgr.ch
Phone: +41 43 928 2912 (Switzerland)

Other resources at http://eippcb.jrc.ec.europa.eu/reference/BREF/GLS_Adopted_03_2012.pdf.

MANUFACTURING ROBOTICS FOR GLASS MANUFACTURING OBJECTIVES

- Advance robotics for glass manufacturing.

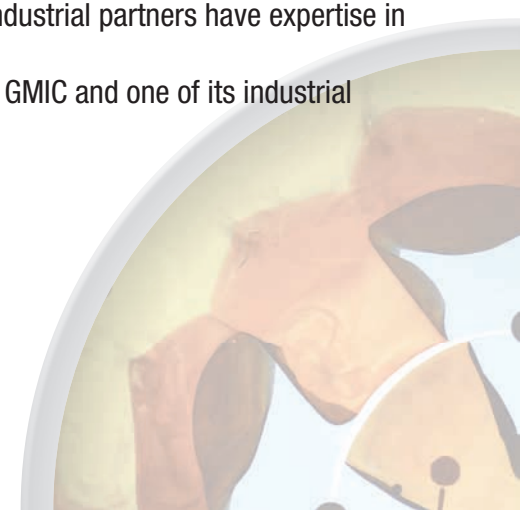
i.) National Robotics Initiative is a massive, well-funded program working on robotic manipulation and manufacturing line applications for robotics. It is worth talking with program managers to find areas of synergy before separately funding/starting similar projects that do not need to overlap.
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503641
Contact: Reid Simmons
Email: resimmon@nsf.gov
Phone: (703) 292-4767

ii.) National Center for Manufacturing Sciences has hosted and continues to have a strong base of industry–research collaborative models, many of which have been focused on robotics in manufacturing applications. Again, it is worth reaching out and utilizing this existing mechanism before attempting to build anew.
http://www.ncms.org/
Contact: Jon Riley
Email: jonr@ncms.org
Phone: (800) 222-6267

Other resources at http://www.industry.usa.siemens.com/drives/us/en/motion-control-systems-and-solutions/motion-control-industry-solutions/glass/pages/glass-manufacturing.aspx; http://matrixti.com/industries/glass-manufacturing/; http://www.varoengineers.com/industries/glass-manufacturing/; and http://www.opsis.se/default.aspx?tabid=1109.

AREAS TO WORK THROUGH WITH TASK FORCE MEMBERS WHO ARE SUBJECT-MATTER EXPERTS

- Define base composition categories (i.e., standard samples)—Society of Glass Technology could be a strong partner here.
- Fit interatomic potentials to glass and melt data, not only to crystals.
- Incorporate batch-to-glass thermodynamics and kinetics into an overall furnace model. (I believe GMIC and one of its industrial partners have expertise in this—Glass Service.)
- Work with suppliers to identify other possible materials reserves and potential opportunities for new deposits. (I believe GMIC and one of its industrial partners have expertise in this—Rio Tinto.)



Policy Objectives Resources

MODELING RESOURCES AND SIMULATION IN GLASS OBJECTIVES

- Revive or reinvent the SciGlass or INTERGLAD database systems and develop new tools or processes to increase its usability.
- Develop integrated databases that contain data on properties, structure, and processing history to increase their usability.
- Develop a secure industry standard database to standardize and streamline collection of materials testing data from all industrial raw-materials suppliers.
- Establish robust infrastructure for secure data access that allows manufacturers to quickly and easily access the data from their suppliers.

There are very large materials and process database initiatives underway worldwide with only a few focused on glass. Again, although they may not be glass centric, the funding and tools are already in place in many of these cases. Therefore, a simple phone conversation and direct bridge to the glass industry may be a very strong impetus for these other organizations to take on the brunt of the work and funding, with the ACerS Task Force providing only some guidance.

i.) GlassTrend already has funded and has large industrial support for precompetitive topics in all areas of glass manufacturing, including extensive modeling of melting processes and materials.
http://www.glasstrend.nl/about-GlassTrend.php
Contact: Elize Harmelink
Email: glasstrend@celsian.nl
Phone: +31 (0) 402 490 100 (Netherlands)

ii.) International Partners in Glass Research has conducted several projects with international partners, primarily for glass packaging, in simulation of manufacturing processes.
https://www.ipgr.com/ipgr-about-us/philosophy.html
Contact: Christian Roos
Email: christian.roos@ipgr.ch
Phone: +41 43 928 2912 (Switzerland)

iii.) International Commission on Glass Atomistic Simulation Committee appears to be the most current large scale, international effort for simulation within the glass industry, holding several current events a year on the topic.
http://www.icglass.org/home/technical_committees/committee/?id=25&committee=TC27:_Atomistic_Simulation
Contact: Jincheng Du
Email: du@unt.edu
Phone: 940-369-8184

GLASS RECYCLING OBJECTIVES

- Incentivize glass recycling through increased legislation to enable materials of acceptable quality to be recovered and processed into a usable form for glass manufacturers.
- Improve infrastructure for glass collection and processing to efficiently and economically increase the quantity and quality of recycled glass.

Again, organizations and initiatives, most notably in Europe, have paved the way in this area. There are several of particular note in the U.S. , however.

i.) Glass Packaging Institute has extensive advocacy initiatives and public-accessible documentation on life-cycle cost analysis, etc., for recycling.
http://www.gpi.org/
Contact: Lynn Bragg
Email: lbragg@gpi.org
Phone: (571) 527-3119

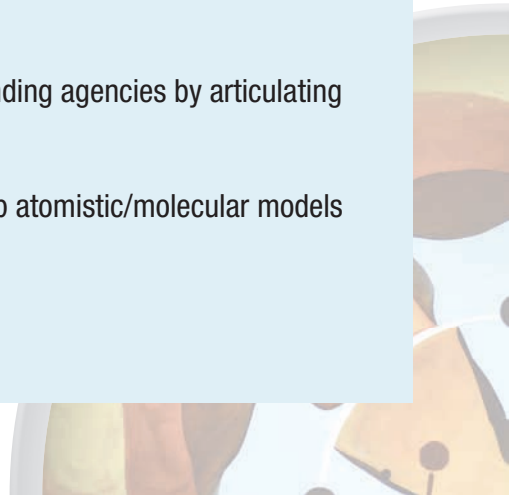
ii.) GMIC's industrial partners and some academic partners are currently in the process of forming a smaller consortium focused on glass recycling and sorting issues, from technology advancements to some policy advocacy.
http://gmic.org/
Contact: Bob Lipetz
Email: rwlipetz@gmic.org
Phone: 614-818-9423

Other resources include National Recycling Coalition.
http://nrcrecycles.org/
Contact: Bob Gedert
Phone: (202) 618-2107

GLASS INDUSTRY–RESEARCH PARTNERSHIP OBJECTIVES

- Establish a needs capture program in the functional glass manufacturing industry at the plant level.
- Increase industry engagement of faculty and students in fundamental and applied research, while also re-engaging funding agencies by articulating the importance of glass research.
- Launch precompetitive research consortia to promote collaborations between companies and universities.
- Work with DOE and NSF to establish a consortium of universities, national laboratories, and funding agencies to develop atomistic/molecular models for glass systems of interest.

See every resource mentioned in the above objectives but especially GMIC, GANA, IGMA, and GPI.



Workforce Development Objectives

- Increase university and industry involvement with high school and middle school teachers.
- Launch industry-funded, interdisciplinary Ph.D. programs on materials development for materials for in situ sensors and other topics with substantial industry interest.
- Establish industrial chair positions for glass professors.

Many of the above objectives focus on the Ph.D. and/or graduate level of glass workforce development. However, there exists most notable, current assets that promote graduate level curriculum in glass, outside of ACerS.

i.) Corning Fulcher Sabbatical Program and Glass Summit. Corning, in partnership with ACerS, hosts the Glass Summit, which provides a strong forum for industry and graduate faculty/students to collaborate. Furthermore, Corning offers a hands-on sabbatical for Ph.D.s to interact with industry-relevant areas of technical and manufacturing interest.
https://www.corning.com/worldwide/en/innovation/culture-of-innovation/fulcher_sabbatical_program.html
https://www.corning.com/worldwide/en/innovation/culture-of-innovation/glass-summit-2016.html
Contact: ACerS has up-to-date contact

ii.) Lehigh University's International Materials Institute for New Functionality in Glass is a resource-rich organization that has grades six through twelve education resources. It also hosts graduate-level research in glass.
http://www.lehigh.edu/imi/
Contact: ACerS has up-to-date contact

Other resources include additional grades six through twelve educator opportunities and/or collegiate-level interdisciplinary curricula on industry-relevant glass topics. NSF regularly releases funding opportunities to pursue the development of these types of programs (i.e., Discovery Research PreK-12 at https://nsf.gov/funding/pgm_summ.jsp?pims_id=500047&org=NSF; listing of more than 3,000 funded projects to date at http://www.cadrek12.org/projects)