Profile 20

Mildred S. Dresselhaus

Institute Professor; Professor of Physics and Electrical Engineering, Emerita
Massachusetts Institute of Technology (MIT)
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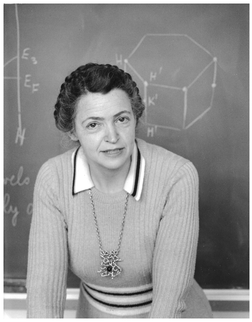
Cambridge, MA 02139
USA



Mildred Dresselhaus at MIT, ca. 1977–1978. Credit: Georgia Litwack.

Birthplace
Brooklyn, New York, NY

Born
November 11, 1930

Tags

- ❖ Academe
- ❖ Domicile: USA
- ❖ Nationality: American
- ❖ Caucasian
- ❖ Children: 4

Publication/Invention Record

>1600 publications: h-index 122 (Web of Science)
8 books

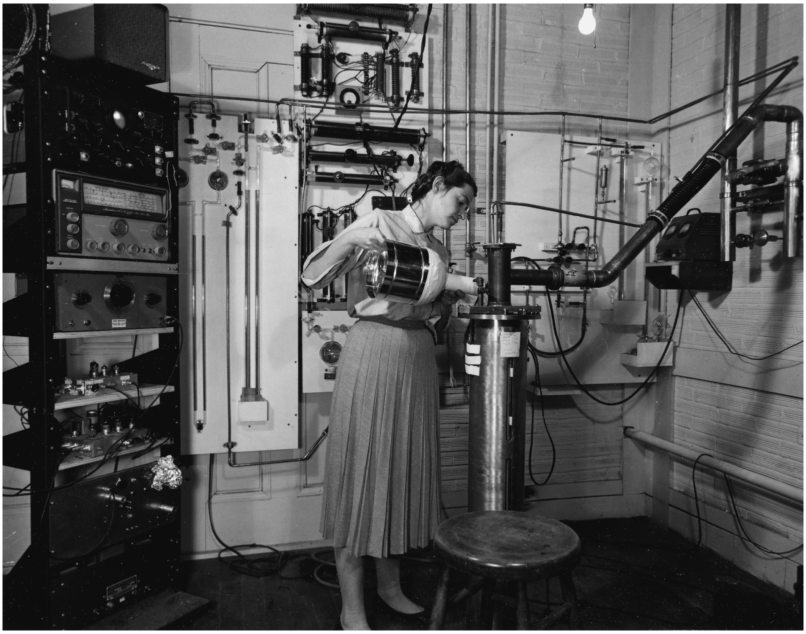
Proudest Career Moment (to date)

It was perhaps my 80th birthday party, when 250 people, including family, former students, friends, and collaborators worldwide, came to MIT to celebrate my birthday and career with a scientific symposium and party. Close to that would be winning the 2012 Kavli Prize for nanoscience, and receiving the prize in Oslo from Fred Kavli and King Harald. Winning the Kavli Prize has spurred me to new research interests. Some special moments came with meeting various U.S. Presidents, starting with George Bush, Sr., followed by most of them since then.

Academic Credentials

Ph.D. (1958) Physics, University of Chicago, IL, USA.
A.M. (1953) Physics, Radcliffe College, Cambridge, MA, USA.
Fulbright Fellow (1951–1952), Newnham College, Cambridge University, England, United Kingdom.
A.B. (1951) Physics, Hunter College, New York City, NY, USA.

Successful Women Ceramic and Glass Scientists and Engineers: 100 Inspirational Profiles. Lynnette D. Madsen.



Mildred Dresselhaus at Cornell University, 1960.

Research Expertise: electronic materials, particularly related to nanoscience and nanotechnology, with special regard to carbon-related materials; novel forms of carbon, including graphite, graphite intercalation compounds, fullerenes, carbon nanotubes, porous carbons, activated carbons, and carbon aerogels; as well as other nanostructures, such as bismuth nanowires, bismuth–antimony thin films, and the use of nanostructures in low-dimensional thermoelectricity

Other Interests: she is widely recognized for her considerable devotion to mentoring students, raising community awareness, and promoting progress on gender equity

Key Accomplishments, Honors, Recognitions, and Awards

- MIT Institute Professor, 1985–2007; emerita, 2008 to present
- 31 honorary doctorates worldwide, 1976 to present
- IEEE Medal of Honor, 2015
- Presidential Medal of Freedom, 2014
- Von Hippel Award, Materials Research Society, 2013
- Kavli Prize "for her pioneering contributions to the study of phonons, electron–phonon interactions, and thermal transport in nanostructures," 2012
- Co-recipient of the Enrico Fermi Award, 2012
- Acta Materialia Materials and Society Award, 2012
- ACS Award for Encouraging Women into Careers in the Chemical Sciences, 2010

- Oliver E. Buckley Condensed Matter Physics Prize, 2008
- Oersted Medal, 2008
- Chair of the governing board of the American Institute of Physics, 2003–2008
- UNESCO/L'Oreal, North American Woman Scientist of the Year, 2007
- Co-chaired a National Academy of Sciences Decadal Study on "Condensed Matter Materials Physics, CMMP2007"
- 11th Annual Heinz Award in the category of Technology, the Economy and Employment, 2005
- Karl T. Compton Medal for Leadership in Physics, American Institute of Physics, 2001
- Medal of Achievement in Carbon Science and Technology, American Carbon Society, 2001
- Director of the Office of Science at the U.S. Department of Energy, 2000–2001
- National Materials Advancement Award of the Federation of Materials Societies, 2000
- Weizmann Institute's Millennial Lifetime Achievement Award, 2000
- Harvard Overseer, 1997–2000
- Trustee, California Institute of Technology, 1993–2000
- Ioffe Institute, Russian Academy of Sciences, St. Petersburg, Russia, 2000
- Fellow of American Carbon Society, 1999
- American Physical Society: Dwight Nicholson Medal for Human Outreach, 1999
- Chairman of the Board, American Association for the Advancement of Science, 1998–1999
- Elected Board of Governors, Weizmann Institute, Rehovot, Israel, 1998
- Hall of Fame Award, Women in Technology International (WITI), 1998
- Award for Outstanding Professional Achievement, Hunter College, 1998
- President, American Association for the Advancement of Science, 1997–1998
- Sigri-Great Lakes Carbon Award, American Carbon Society, 1997
- Elected President of the American Association for the Advancement of Science, 1996
- Treasurer, National Academy of Sciences, 1992–1996
- Elected to Membership in the American Philosophical Society, 1995
- Elected as a Foreign Associate of the Engineering Academy of Japan, 1993
- Trustee, Rensselaer Polytechnic Institute, 1988–1992
- Achievement Award, New York Academy of Sciences, 1991
- National Medal of Science, 1990
- Elected to Council of National Academy of Sciences, 1987–1990
- Annual Achievement Award, Engineering Societies of New England, 1988
- Elected to Council of National Academy of Engineering, 1981–1987
- Elected to Board of Directors of the American Association for the Advancement of Science, 1985–1989
- MIT Killian Faculty Award, 1986

- Elected to membership in the National Academy of Sciences (Engineering Sciences Section), 1985
- Elected President of the American Physical Society, 1984
- MIT Abby Rockefeller Mauzé Professor of Electrical Engineering, 1973–1985
- Society of Women Engineers Achievement Award, 1977
- Corresponding Member, Brazilian Academy of Sciences, 1976
- Elected to membership in the U.S. National Academy of Engineering, 1974
- Elected to Fellow of the American Academy of Arts and Sciences, 1974
- Radcliffe College Alumni Medal, 1973
- Hunter College Hall of Fame Award, 1972
- American Physical Society Fellow, 1972
- NSF Postdoctoral Fellow, Cornell University, 1958–1960
- Bell Telephone Laboratory Fellow, 1956–1957
- Fulbright Fellowship, 1951–1952

Some activities where she served as trustee, on corporate boards, consulting, on visiting committees, editorships and publication boards, in professional society service, and guest lectureships are not included in the above list.

Biography

Adapted from her website (that is no longer available) that included the writings of Gene Dresselhaus.

Early Life and Education

She was born in Brooklyn, New York, in 1930 and was given the name Mildred Spiewak, named after her mother's mother, who died when her mother was about 5 years old. The Spiewak family's roots can be traced back to a small mostly Jewish village in southern Poland. When she was 4, her family moved to a Jewish ghetto in the Bronx where her parents took whatever unskilled jobs they could find. Their early years in New York were more difficult because of the Great Depression. Even though family resources were very limited, her mother managed to send money to European relatives what little she could—in the end, however, almost all family members remaining in Europe were killed in the Holocaust.

The family moved to the Bronx when she was 4 years old so that her older brother, Irving, could be close to a music school where he was given a scholarship to study the violin. But the teacher died soon after, and music lessons moved to Greenwich Village. As a very young child, Mildred accompanied her brother to his violin lessons and listened to him practicing his instrument, and soon she could sing the various pieces he was playing. This led to her starting violin lessons before she was 5 years old and before she started kindergarten. She learned to read music before she could read words in English. Throughout her elementary and junior high school years, she continued her music lessons as a scholarship student at the Greenwich House Music School (in Manhattan), which was nearly one hour away by subway from where she lived in the Bronx. Because of her considerable musical skills, she was also able during her childhood to make friends and move in more affluent circles outside of the ghetto where she lived. These contacts increased her aspiration level and exposed her to the cultural life of New York City.

Mildred attended the local public school, just two blocks from her apartment house, for grades K–6. For her junior high school (grades 7–9), Millie attended a public school only five blocks from her home. Her favorite subject was mathematics. She was a curious but shy student, and especially enjoyed the beginning of each semester when she received the books that were lent to her. This was an opportunity to read through the math book the first week to get a preview of what she would be learning. As she got older, science books for the semester were also lent to students, so she also read through those textbooks during the first week of class. Some of the memorable things she did in elementary school were given as special assignments. The first was a job to teach a "mentally retarded" boy to read. So at the age of 8 years, she had her first paying job, earning a total of 50 cents per week for three hours of hard work daily. When she was 11 years old, she had a non-paying job as an assistant to her sixth grade teacher, helping her with administrative work and other assignments.

Millie's aptitude and interest in science would also have taken her to Bronx Science, but girls were not allowed into the Bronx High School of Science at that time. Through her contacts she also learned about the possibility of attending a special high school for girls in New York City (Manhattan). Admittance to this high school was by examination, and only 80 girls from the whole city were accepted per semester. Since nobody from her junior high school had ever passed this entrance exam, she undertook an intensive self-study program of math and English exams given in past years for entrance into this school. Using this strategy, she managed to pass the examination, and she became a student at Hunter College High School. This event can be considered the "entry point/junction" that led to her becoming a scientist.

The central focus of Hunter College High School was liberal arts, with emphasis on English, literature, history, Latin, modern languages (taught in the vernacular), current affairs, and speech. As it turned out in later life, a high level of exposure to the liberal arts provided excellent background for the large amount of writing necessary in a scientific career. The class on speech, which was required every semester, was the least interesting to her, but proved to be one of the most valuable in later life. It was here that she learned about public speaking, about improving her diction, projecting her voice, and also how to put herself to sleep at will for a short nap in the middle of the day (in an appropriate time and place for a nap). The emphasis on self-study provided skills at reading texts critically, and in identifying weaknesses or flaws in logical thinking. The subjects that interested Millie most as a high school student were her math and science classes. At this high school, there were generally two or three student teachers in the classroom who were valuable in helping students with self-study projects, in answering questions outside of classroom study, and in pointing students in new directions, by providing many one-on-one learning experiences. Another aspect of this high school that turned out to be valuable was the fact that the school had no cafeteria; therefore, students had to bring their own lunches with them. Lunch was eaten during “noon time club meetings” and she had opportunities to join many clubs, such as the Math Club, Orchestra, Public Affairs Club, etc. This is where students got to know one another, and where they developed leadership skills. It was through the high school clubs that she picked up her nickname “Millie” that has been subsequently used widely in place of her formal name of Mildred.

Hunter High channeled her into Hunter College with the goal of becoming an elementary school teacher. At that time, women typically chose one of three careers: K–12 teaching, nursing, and secretarial work. On the basis of her ranking on the New York State Regents exam, she was offered a scholarship to Cornell University. However, Cornell was far away from home and seemed to her like a wealthy man’s school. So Millie decided to continue on to Hunter College where she felt very comfortable both socially and academically. Though she didn’t know it at the time, this decision to attend Hunter College (which was relatively weak in the sciences) was decisive in launching her into a scientific career. The reason for this change in career objectives can be traced to one particular faculty member, Rosalyn Yalow, a future Nobel Laureate, who became Millie’s advisor, mentor, and physics professor at Hunter College in her second year. Rosalyn followed Millie’s career throughout her life and always seemed to be present whenever Millie was involved in either a minor talk or a more major event in the NYC area. This remained true for many years, as illustrated by Rosalyn’s attendance in a wheelchair at an award ceremony for Millie at Hunter College in 1998. It is also fair to say that she chose her lifework in science because she loved it so much as a youngster, and this love and fascination for the unknown and for the discovery of new things, not yet known before, has remained with her throughout her life.

After graduating from Hunter College, Millie was awarded a Fulbright Fellowship, which allowed her to spend a year at Cambridge University in England. Her studies during this year focused on physics, and she was able to largely make up for the rather limited curriculum in physics that was offered at Hunter College.

Upon returning to the United States, Millie spent a year at Radcliffe College (now part of Harvard University) where she was awarded a master’s degree. She then continued her graduate studies at the University of Chicago (where Enrico Fermi was one of her professors). The first year of her studies coincided with the very end of the Enrico Fermi era, and consequently her training in physics had a very strong flavor of the Fermi approach to research and teaching in physics. She met Gene F. Dresselhaus, now a well-known theorist, while doing her Ph.D. studies at the University of Chicago; they married in 1958.

Finally, she went to Cornell University where she worked as a postdoctoral fellow (with National Science Foundation support) while her newly acquired husband was on the faculty. While at Cornell, she worked on a model to explain the experimental results of her Ph.D. thesis. The times were such that women’s careers were not taken very seriously by most men. For example, while at Cornell, Millie was told by the head of the laboratory with which she was affiliated that “a woman could never teach an engineering student.” So with the expiration of the NSF postdoctoral fellowship in 1960 and the birth of a new baby, it was time to move on.

Career History

In the early 1960s, hiring of couples was rare. As they saw it, there were two choices—MIT and IBM. She was more interested in basic science and an academic career, so they chose MIT.

Lincoln Laboratory was affiliated with MIT and provided an excellent environment for a young person to develop a career. At Lincoln Laboratory, she was not able to continue with her superconductivity research, so she used this disappointment as an opportunity to branch into the study of magneto-optical effects in semiconductors and semimetals. The bias against superconductivity research came from her division leader, Benjamin Lax, who felt that the Bardeen–Cooper–Schrieffer theory had explained everything about superconductivity, and the field was now dead. Changing fields turned out to be the best thing that could have happened at this early time in her career in solid-state physics, and in her training of graduate students later on, she emphasized the importance for a young person to learn several research areas in the early career years.

Her earliest work at Lincoln Laboratory was on magneto-optics studies in semiconductors, where many others were also working at that time. Wanting to do something different from what others were doing, she started to study the electronic structure of graphite by magneto-optics, following a suggestion by her husband. She had little competition in this field because the magneto-optics experiment was considered difficult and the graphite electronic structure was at that time considered to be very complex. This situation was fortunate because the low general interest in this topic kept down the completion at a time when her next three children were born.

She supervised her first Ph.D. thesis in 1965 and now more than 60 people have earned their doctorates under her supervision. As a result of her research achievements during the years 1960–1967, she was invited to become a visiting professor in the Electrical Engineering Department at MIT under the auspices of the Abby Rockefeller Mauzé Fund for woman scholars. After one year as a visiting professor, she was appointed as a tenured full professor, the first female tenured professor in MIT's engineering school.

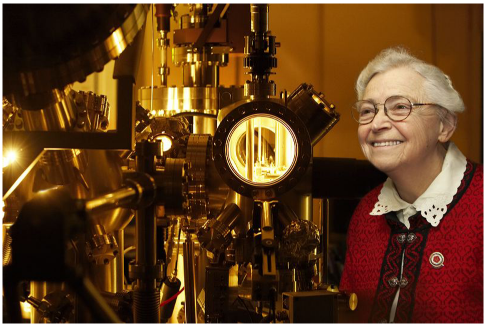
When she was appointed to a full faculty position and to the Abby Rockefeller Mauzé Chair in 1973, she had enough intellectual and financial independence to attempt high-risk experiments that federal funding agencies did not find worthy of support. This independence provided her with greater freedom and helped her on the path to becoming a resource person worldwide in the carbon science area, and giving her entry to many new fields of carbon science as they emerged. Along with this came many invitations to give invited talks and write review articles, books, and monographs, and the unofficial title "Queen of Carbon." When her visibility on the national scene was greatly enhanced (starting in 1974 with election to the National Academy of Engineering), she began receiving several recognitions; these have continued through the years.

In 1983, after she had been elected to become an upcoming president of the American Physical Society, she received a joint appointment between the Physics Department and the Department of Electrical Engineering and Computer Science. Her teaching focused on educating electrical engineering and materials science students about solid-state physics, group theory, and semiconductor physics, and in making this material accessible to such students. She held the Abby Rockefeller Mauzé Chair until 1985, when she was appointed to the position of Institute Professor. One indicator of her research success is that several physical theories include her name: the Hicks–Dresselhaus model for thermoelectric materials (1993), the SFDD ([Riichiro] Saito, [Mitsutaka] Fujita, [Gene] Dresselhaus, and [Mildred] Dresselhaus) model for carbon nanotubes (1992), and the Tang–Dresselhaus theory for bismuth–antimony thin films (2012).

She has made extensive research contributions and fundamental discoveries in condensed matter physics. One significant factor to her successful career is an exceptional skill in assessing a situation and deciding on exactly where she could fit in and make a significant contribution. Having made this decision, she gets in, and in a timely manner makes her contribution and then moves on to the next problem. It is likely that her early childhood experiences were instrumental in developing this intuitive strategy.

Mid-career, reflecting on her fortunate career development and recalling the training that she had received at Hunter College, Millie thought it was the time to return something to the pool from which she had been drawing all these years. To her, this "service to society" meant accepting administrative positions and service assignments in order to help other researchers and students do the science that was so important in her own life. One main emphasis of her leadership was to initiate new seed research programs, which were nurtured through funds from the Center for Materials Science and Engineering, which then grew into major programs. Another emphasis was in the grooming of young people for leadership positions, who could then become laboratory directors, so that she could go back to her other activities, after her term of office was over. Her ability to perform these service activities was possible in part due to two factors: their children had grown up and her husband joined the laboratory she worked in, which gave him freedom to work extensively with the Dresselhaus research group as well as on his own projects.

Throughout the years, Millie has been active in helping women in science and engineering in various ways. These efforts include mentoring women, examining how undergraduate admissions applications were handled at MIT, initiating a Women's Forum at MIT, serving on various studies and task forces, starting two initiatives for women in science and engineering while she was the Abby Rockefeller Mauzé Professor, serving on the Committee on the Status of Women in Physics of the American Physical Society, and chairing the National Research Council Committee on Women in Science and Engineering for three years (from 1990 to 1993). Millie has always taken great pride in the accomplishments of her students, including their work on broader issues in science and technology. She has also enjoyed working with graduate students, postdocs, and collaborators worldwide as science and technology have become more and more international.



Mildred Dresselhaus in the laboratory, 2011. (See insert for color version of figure.)

In addition, Millie Dresselhaus has been blessed with five grandchildren—clearly making her one of the most famous grandmothers in science today.

3 Most Cited Publications

Title: Large area, few-layer graphene films on arbitrary substrates by chemical vapor deposition
Author(s): Reina, A; Jia, X; Ho, J; Nezich, D; Son, H; Bulovic, V; Dresselhaus, MS; Kong, J
Source: Nano Letters; volume: 9; issue: 1; pages: 30–35; doi: 10.1021/nl801827v; published: January 2009
Times Cited: 2294 (from Web of Science)

Title: Edge state in graphene ribbons: nanometer size effect and edge shape dependence
Author(s): Nakada, K; Fujita, M; Dresselhaus, G; Dresselhaus, MS
Source: Physical Review B; volume: 54; issue: 24; pages: 17954–17961; doi: 10.1103/PhysRevB.54.17954; published: December 15, 1996
Times Cited: 2061 (from Web of Science)

Title: Electronic structure of chiral graphene tubules
Author(s): Saito, R; Fujita, M; Dresselhaus, G; Dresselhaus, MS
Source: Applied Physics Letters; volume: 60; issue: 18; pages: 2204–2206; doi: 10.1063/1.107080; published: May 4, 1992
Times Cited: 1853 (from Web of Science)

Challenges

In retrospect, my greatest challenge came in my childhood, growing up in New York City "on the wrong side of the tracks." I had poor access to information about the possibilities for careers for women from either my home or school environments. This challenge was overcome by my musical education, which exposed me to education and advancement opportunities available to people "on the right side of the tracks." Once in Hunter High School, ability, dedication, and interest became the criteria for advancement and not family income or status.

A second challenge came when I was considering college education, and my school guidance advisors recommended a career for me as a school teacher, because it was the best available option for a person with no family funding. Going to Hunter College solved this problem, because the faculty members there pointed me along fruitful directions available to me, and provided me with tutoring jobs. Being told at Cornell that there was a limited future for me in science pointed me to give high priority to institutions emphasizing meritocracy, and this resulted in my coming to MIT in 1960, where actual accomplishment rather than what you looked like was what mattered.

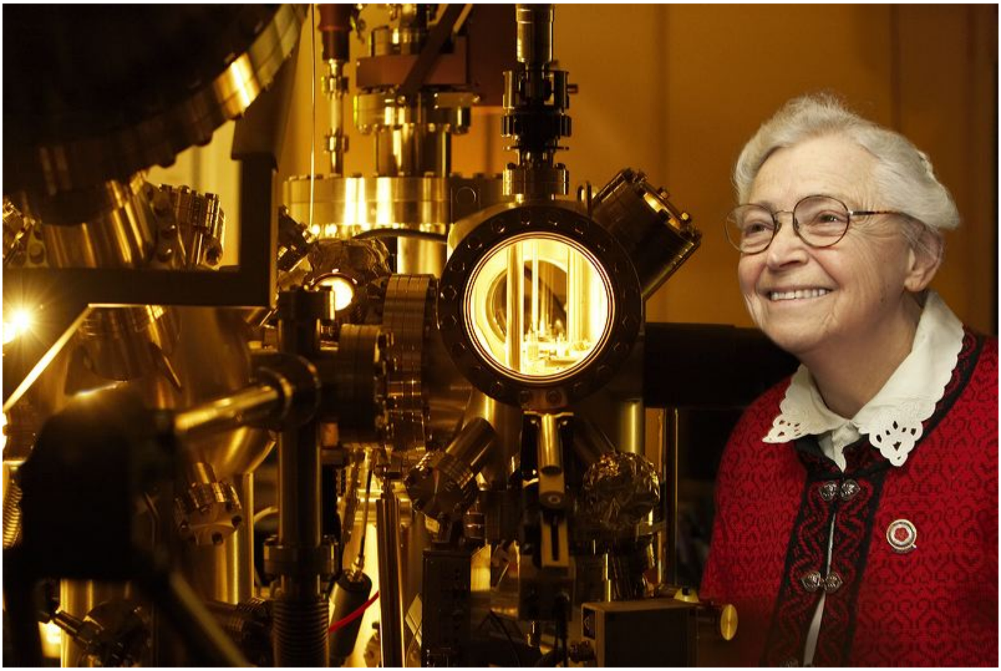
My next challenge was in 1990 when the National Magnet Laboratory moved from Cambridge, Massachusetts, to Tallahassee, Florida. This necessitated a change in research focus away from high magnetic field research to studies on nanocarbons and nanothermoelectricity, two research areas that have since then grown dramatically in importance, more than high magnetic field research. The take-home message here is to learn how to use setbacks to reorient your personal goals, taking advantage of newly emerging opportunities. Learning new things and bringing a broad background and a high level of motivation allowed me to move forward successfully and to benefit from adversity.

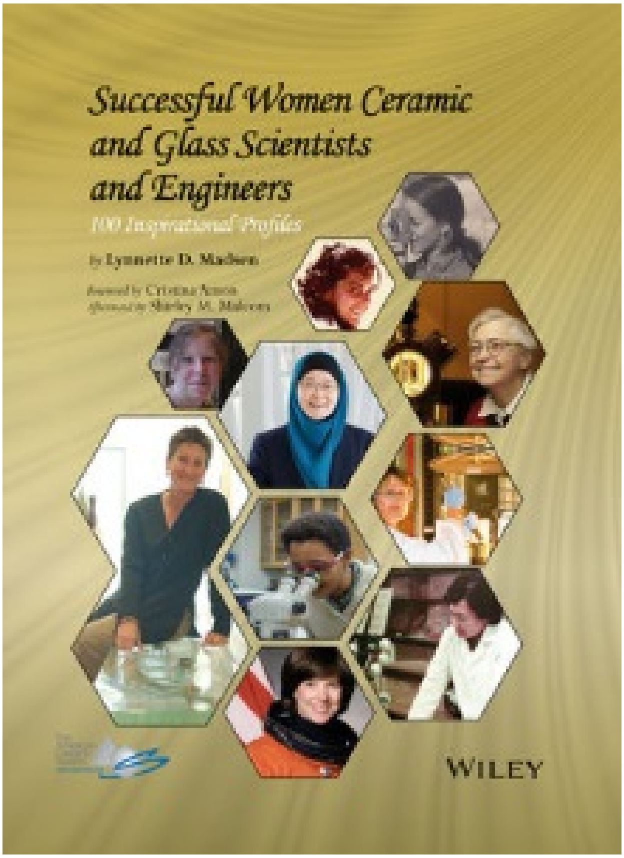
On being a woman in this field . . .

Being a woman in this field has been both a challenge and an opportunity. Working in a research field where one is greatly outnumbered often leads to challenges, because the minority person is not expected to succeed so well in the given research field. If the research field and institution of employment emphasize meritocracy, then many of the barriers associated with being a minority are lowered, and evaluation emphasizes achievement rather than preconceived expectations. The advantage of being a woman in my field is that there are so few of us, especially in my age group, so my achievements are more noticed. This has in fact been a big advantage for me in my career. Furthermore, many women are less excited about their professional success and are happy with a successful family life in conformance with societal expectations. The take-home message here is to enjoy and gain satisfaction from what you are doing, both in your personal activities and in your professional activities. I believe that women can be happy and successful doing both at the same time.

Words of Wisdom

Words of wisdom that I give to women are that “they can do it also.” I also say that careers in science and engineering are great careers for women, because the jobs are interesting, well paying, and appreciated by society. These are great career choices if the woman has an interest in such careers, the necessary talent to do the work, and a willingness to be flexible and adaptable to find ways to move forward when challenges present themselves.

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