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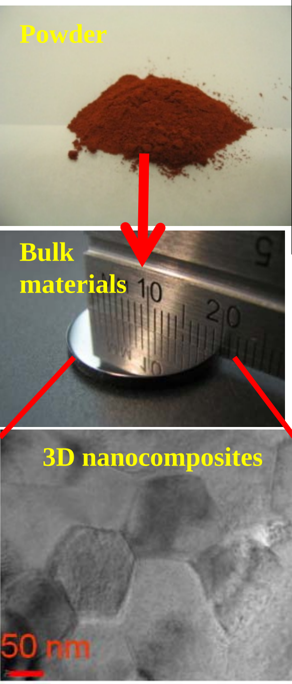
Research Program: The overarching research theme is producing large-sized (bulk) nanocrystalline materials. By leveraging nanostructured and controlling defects (point defects, grains boundaries) we can engineer materials for a variety of applications. Currently the majority of our efforts are in producing ceramics for optical (optical-structural, electro-optic, magneto-optic) and magnetic applications (exchanged coupled magnets and devices). (We also have a significant effort in thermoelectric materials for power generation. Our primary strength is that we can efficiently produce *large sized 3D nanocrystalline* materials with a) small grains and b) varying composition .

Areas of expertise: Materials processing, nanocrystalline materials, Current activated pressure assisted densification (CAPAD) *aka* Spark Plasma Sintering (SPS) .



Why 3D nanocrystalline materials?

→Materials with very **small crystal sizes** have remarkably **different (length scale derived) Properties**

→ New materials could be used for a host of magnetic applications

Processing Strategies

1)Densify nanocrystalline powders quickly to suppress excessive grain growth

→ Use electric current activated processing technique

→Produce clean interfaces

Research Partners Needed:

• Modeling (properties)

•Characterization experts

Research Facilities available in AMPS Lab

- CAPAD apparatus (custom built)
- Custom built PVD chamber, (integrated sputter, e-beam, and thermal evaporation)
- **Central Characterization facilities** : Quantum Design MPMS , PPMS, Electron microcopy

Research Results:

Major processing technique: CAPAD

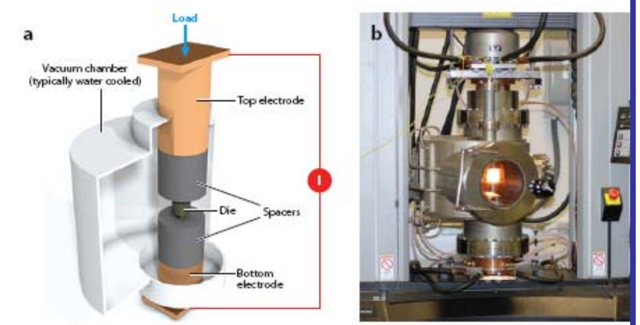
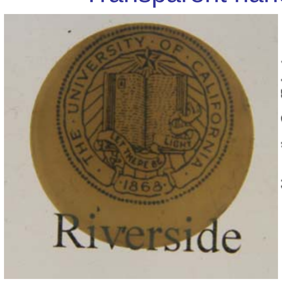
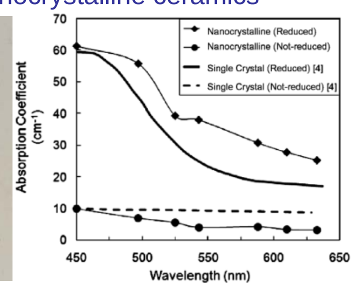


Figure 1

(*a*) A schematic depicting the main components of a current-activated, pressure-assisted densification (CAPAD) apparatus. (*b*) A picture of a CAPAD apparatus during an experiment. This particular system was custom built at the University of California, Riverside.

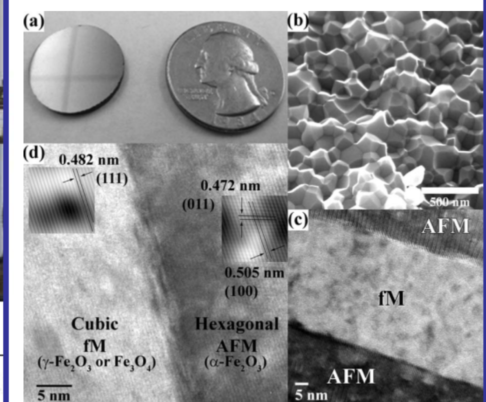
Transparent nanocrystalline ceramics

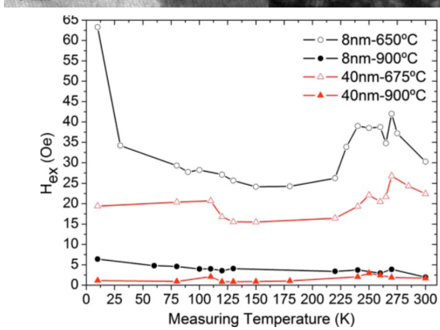




Figures 3:Optically transparent nanocrystalline oxide. Colors can be varied. Optical properties are comparable to single crystals

Exchange coupled magnetic oxides





Figures 2: a-d pictures and micrographs of 3D nanocomposites e) magnetic measurements showing coupled properties