The CIRE Project and the Materials Research Science and Engineering Center (MRSEC)

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The CMU MRSEC

NSF Materials Research Science and Engineering Center (mesoscale interface mapping project), since 1996.

Pennsylvania Technology Infrastructure Authority.

Collaborative to Integrate Research and Education with FAMU.
CMU MRSEC Technical Objectives

To develop predictive models for microstructural evolution that use experimentally determined grain boundary properties.
Advanced Microstructure Characterization

High resolution SEM coupled with OIM and serial sectioning to map the three dimensional mesostructure of polycrystals.
Advanced Microstructure Characterization

Observations of $7 \times 10^6 \, \mu m^2$ of boundary plane area, surrounding 5000 grains, in 1 mm$^3$ of sintered MgO

Three dimensional space of unique grain boundary misorientations

Two dimensional space (projected along [001]) of unique grain boundary planes, for misorientations about $<111>$. 
Reconstruction of Grain Boundary Properties

Population of boundaries observed in polycrystalline MgO

Relative energy as a function of inclination plane, determined by the capillarity vector reconstruction method assuming local equilibrium at the triple junctions.

Boundaries with a 6° misorientation about <111>

Boundaries with a 60° misorientation about <111> ($\Sigma 3$)
Why is the CIRE important for the MRSEC?

• Educational objectives: microstructure course is important for students conducting Center research.

• Research objectives: similar technical interests among FAMU faculty allow vital research projects to be undertaken.

• Diversity objectives: increases the participation of underrepresented minorities in MRSEC research.

Oscar Castillo, summer ‘00
Joint Projects

• Effect of temperature on the surface energy anisotropy of MgO

• The energies of grain boundaries in non-oriented electrical steel.

• A new spectral approach to microstructural design and its application to grain boundary engineering.
Effect of temperature on the surface energy anisotropy of MgO (M. Adams)
Presentation of Results

Preparing a poster

At the Gordon Research Conference (Ceramics), summer ‘00
Summary

The CIRE project has been essential for the CMU MRSEC to achieve its education, research, and diversity goals.