IOWA STATE UNIVERSITY

Materials Science & Engineering Department

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Preliminary Oral Examination
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Tuesday, June 10 · 11:00 AM · 1322 Hoover Hall

"Developing a high conductivity, high strength, and lightweight Al/Ca composite conductor for high voltage power transmission purposes"

More efficient long-distance, high-voltage power transmission technologies would allow substantial reductions in carbon-combustion energy use. High conductivity, high strength and low density are the major desired properties of conductor materials for overhead long distance power transmission. Improving conductor performance with regard to these three parameters would result in powerline construction cost savings and improvement in transmission efficiency and system reliability. A new deformation processed Al/Ca composite conductor now in development is expected to offer large benefits on these properties compared with currently available ACSR, AAAC, ACAR, and ACCR conductors, especially for high-voltage, direct-current transmission. This Al/Ca composite conductor is produced by powder metallurgy and severe mechanical deformation of two ductile metal phases. In previous studies, commercially available coarse Ca granules (diameter ~1.2 mm) were mixed with high-purity Al powders from the Ames Lab GARS process to produce the first generation of Al/Ca composite conductor material. This material had high conductivity and low density, but the strength of the first generation composite showed no advantage over conventional conductors due to the coarse, 2- to 3-micron Ca filament thickness present in the wire after deformation processing. A rotating disk centrifugal atomization device fabricated by Ames Lab has been successfully used to produce fine Ca metal powders (around 200 microns) for production of the next -generation Al/Ca composite. The resultant fine Ca filaments are expected to be around 200 nm in an Al matrix, which theory predicts would increase the strength of the composite to twice as much as ACSR without compromising its high conductivity and low density. The next stage of this project will produce this next-generation of Al/Ca conductor and test its strength, conductivity, and density. Some intellectual merits of this project include: experimental investigation of the microstructure-strength relationship; qualitative simulation of interfacial diffusion driven microstructural evolution at elevated temperature; development of a dislocation-density-based strengthening model and a size dependent resistivity model for metal-metal composites.