NEBRASKA CENTER FOR ENERGY SCIENCES RESEARCH

Cycle 11
January 2017

Investigator: Jeff Shield

Position Title: Professor

Department: Mechanical & Materials Engineering

Email: jshield@unl.edu

Phone: (402) 472-2378

Webpage: http://engineering.unl.edu/mme/jeffrey-shield/

Making Light-Weight Mg-Metal Laminated Nano-Composites

Abstract. With increasing demand for improved fuel efficiency, reducing the weight of structural components in automobiles is critical. Mg alloys/composites have a high strength-to-weight ratio and low density (64% of the density of aluminum and 22% of the density of steel), making it the most promising for structural applications. Replacing steel structural materials with Mg-based materials in automotive applications would boost fuel efficiency by more than 50%.

For structural automotive applications, the strength and deformability of Mg must be increased. For structural metals, a ten-fold increase in the strength has been achieved by refining the grain size from traditional coarse-grained levels (>10 μm) to the nanoscale (<100 nm). One classic process to create bulk nano-grained materials is severe plastic deformation, where dynamic recrystallization produces fine-grained material. However, creating nano-grained Mg by severe plastic deformation has proved challenging, as twinning prevents the refinement of grains. The innovation of this proposal recognizes that twinning is the key barrier to nano-Mg and develops a novel scheme to refine twinning by synthesizing Mg-Metal laminated nano-composites in the bulk. **We hypothesize that interphase boundaries can be designed to increase strength while limit twinnability of Mg**. **The goal of this proposal is to develop a groundbreaking method for synthesizing nano-Mg-Metal composites in bulk form that will take advantage of grain refinement strengthening.**

This proposed work captures the priority research directions of the DOE-BES in its report on *Materials under Extreme Environments* by “Exploring Thermomechanical Limits of Materials”, and is a best fit for *NSF-Designing Materials to Revolutionize and Engineer our Future (DMREF)*, which integrates materials discovery, development, property optimization, and systems design and optimization, with each employing a toolset to be developed within a materials innovation infrastructure. By integrating PIs’ expertise (synthesis, characterization, theory and computation), PIs aim at developing future proposals to NSF-DMREF and DoE-BES.