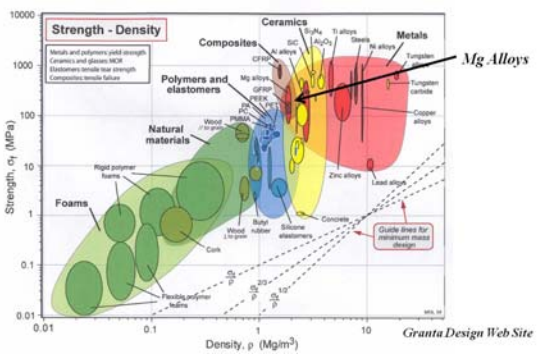
Ultra-Lightweight Magnesium Alloys for Enhanced Protection

S&T Campaign: Materials Research
High Strain Rate and Ballistic Materials

Laszlo Kecskes, (410) 306-0811
laszlo.j.kecskes.civ@mail.mil

Research Objective

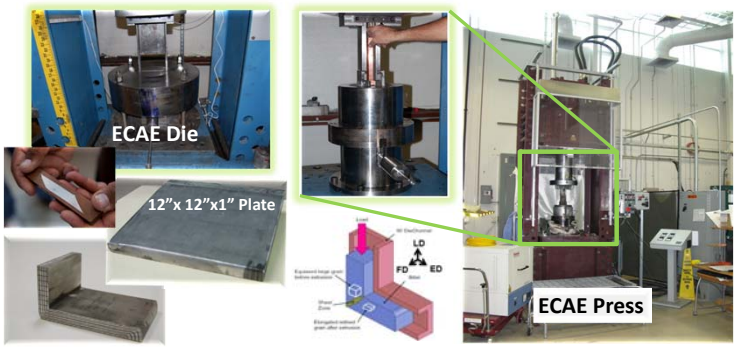
- Elucidate fundamental deformation mechanisms, texture evolution, and high-strain-rate behavior
- Utilize computational materials science tools for alloy discovery, prediction of deformation behavior, and enhancing processing methodology
- Develop processing science and methodology to create fine-grained alloys with controlled texture



Strength-Density Trade-off for Engineering Materials

ARL Facilities and Capabilities Available to Support Collaborative Research

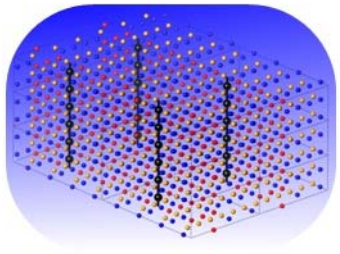
- Severe plastic deformation processing, via equal channel angular extrusion (ECAE)
- Hybrid and step-down ECAE processing route to refine grain size without recrystallization
- Access to high-end characterization facilities in-house to link texture and mechanical properties



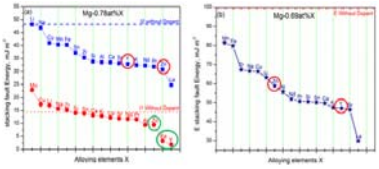
ECAE Processing Suite in Both Bar and Plate Geometries

Challenges

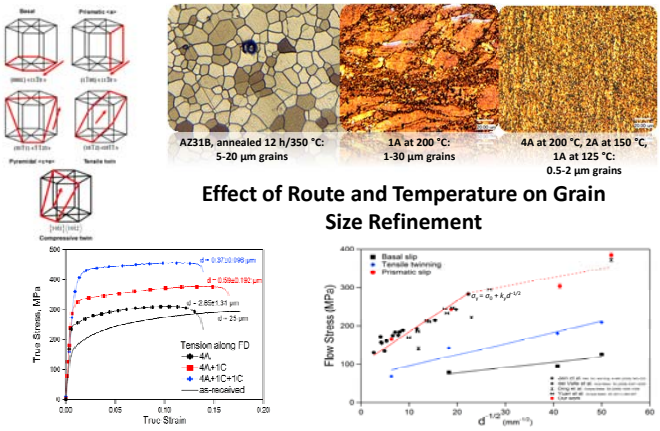
- Low symmetry of Mg crystal structure causes highly anisotropic deformation behavior, limiting applicability of conventional processing methods
- Poor corrosion resistance of most Mg alloys remains a key barrier to widespread utilization
- Existing alloy chemistries and resultant mechanical properties are not optimized for demanding applications
- Deformation processing routes developed to date are encouraging, but do not provide a comprehensive suite of options in meeting objectives



Prediction and Verification of Long Period Stacking Ordered, LPSO, Structures for Grain Refinement



First-Principles Computation of Alloying Element-Based Lowering of Stacking Fault Energy



Effect of Route and Temperature on Grain Size Refinement

Correct Combination of Temperature and Route Results in Dramatic Improvement in Strength and Deformation Mechanism

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Computational efforts at the lower length scales, e.g., phase field
- Alternative deformation processing methods to create specific textures
- Scale-able fabrication methods for alloy discovery and synthesis
- High-strain-rate, in-situ diagnostics at micrometer-microsecond length-time scales
- High-end, high-throughput characterization techniques, e.g., HR TEM, APT, EBSD