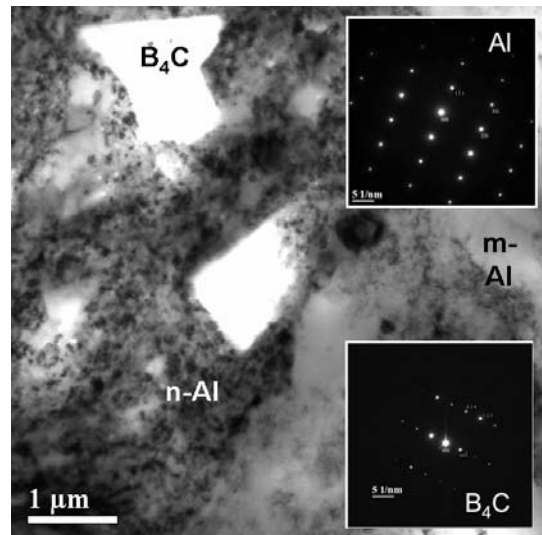
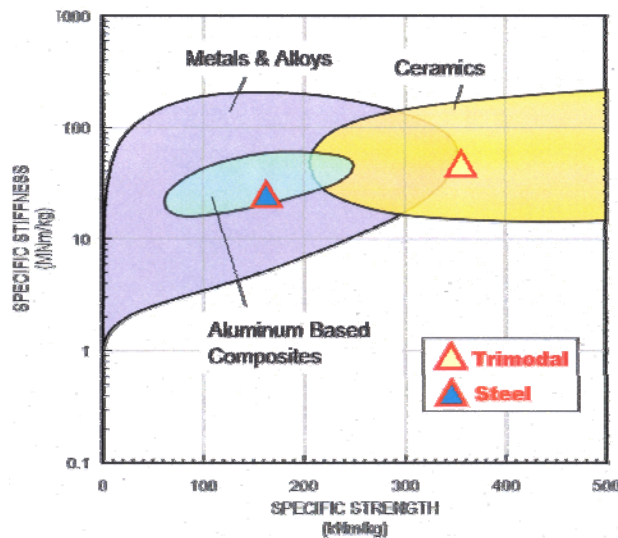


## Multiscale Nanoengineered Trimodal Aluminum Composites Manufacturing

Microstructure design of the trimodal (Al) composites is based on a multiscale composites material process concept and intended to simultaneously increase strength, ductility, and modulus through a combination of conventional composites processing, powder metallurgy techniques, and nanoengineering. Trimodal aluminum (Al) composites are composed of a coarse micron Al alloy grain matrix reinforced with boron carbide ( $B_4C$ ) particulates embedded in ultrafine/nano Al alloy grain submatrix. Laboratory scale fabrication of trimodal Al composites has demonstrated a highly dramatic increase in quasi-static and dynamic compressive strengths strain to failure under dynamic compressive loadings. The increased strength of the trimodal Al composites is attributed to a myriad of mechanisms including grain size, particulates, and dislocation density strengthening, and additional strength associated with defect free metallurgical interfaces between the coarse and fine grained Al and between the  $B_4C$  particles and Al. In order to rapidly install large commercial-scale trimodal Al composites manufacturing capacity with an assurance in transition of critical mechanical properties for large scale product forms, a unified trimodal Al composites manufacturing strategy has been established and dynamically implemented by the Army's trimodal manufacturing centric government-academia-industry team. To date, the trimodal manufacturing centric team has manufactured an 8x8x1 inch trimodal Al composites plates and multiple 75 kg, 14-inch-diameter trimodal billets. The trimodal Al composites plates are to be continuously optimized for vehicle survivability and other civilian applications.



### References/Publications

- Ye, J., et al., A tri-modal aluminum based composite with super-high strength, *Scripta Materialia* 53 (2005) 481-486.
- Zhang, H., et al., "Superlightweight Nanoengineered Aluminum for Strength under Impact", *Advanced Engineering Materials* 9 (2007) 355 -359.

**Patent or steps toward commercialization:** ARL is implementing three Cooperative Agreements and one SBIR Phase II for the trimodal Al composites commercialization.

**Contributing Agency:** DoD / ARL, ONR