Announcing the Final Examination of David Ward for the degree of Master of Science

Time & Location: November 7, 2014 at 11:00 AM in AMPAC 152 Conference Room
Title: Graphene Oxide Reinforcement in Plasma Sprayed Nickel-5Aluminum Coatings

Metallic plasma sprayed coatings are widely used in the aerospace industry for repair on worn engine components. However, the inherent defects in these coatings limit the variety of repairs and reduce the service life of the repaired parts. A potential solution to overcome this problem is to mix small amounts of inexpensive graphene oxide in the powder feedstock. The incredible strength to weight ratio of graphene oxide makes it a viable additive to improve mechanical properties of metallic plasma sprayed coatings. The powder system chosen for this research is Nickelâ€“5Aluminum since it is a common coating for such repairs. The greatest challenge was retaining graphene oxide, which combusts at 400 Degrees C, while melting the Nickel above 1450 Degrees C using a high temperature plasma plume. Graphene oxide was successfully retained in the coatings using either of two configurations: (1) Injecting the graphene oxide powder via solution suspension separately from the metal powder, or (2) Installing a shroud on the front of the plasma gun and backfilling with Argon to inhibit combustion. The uniquely designed solution suspension configuration resulted in a higher deposition efficiency of graphene oxide while the inert shroud configuration had a more homogeneous distribution and retention of graphene oxide in the coatings. The best overall coating was achieved using the inert shroud configuration using a powder mixture containing 2% weight Edge Functionalized Graphene Oxide. Vickers microhardness increased 46% and tensile adhesion strength increased 26% over control samples. This is possible due to the mechanisms of dislocation strengthening and stress transfer previously reported in graphene oxide reinforced Aluminum composites formed by flake powder metallurgy. It was also observed that the energy released by the combustion of graphene oxide helps to uniformly melt the Nickel particles and improve the coating microstructure, allowing for more forgiving spray parameters. The methods developed and results attained in this research open opportunities for graphene oxide to be added as inexpensive reinforcements to other metallic compositions for widespread use in metal matrix composite manufacturing.

Major: Materials Science and Engineering

Educational Career:
Bachelor's of Mechanical Engineering, BS, 2012, University of Oklahoma

Committee in Charge:
Sudipta Seal, Chair, Materials Science and Engineering
Raj Vaidyanathan, Materials Science and Engineering
Helge Heinrich, Physics, Materials Science and Engineering
Lei Zhai, Chemistry, Materials Science and Engineering

Approved for distribution by Sudipta Seal, Committee Chair, on October 23, 2014.

The public is welcome to attend.