PURDUE
UNIVERSITY

School of Mechanical Engineering

ZUCROW LABS SEMINAR

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Self-propagating exothermic reactions in nanoscale multilayer foils and ball-milled powder compacts of the Nickel-Aluminum system.

Abstract:

The kinetics of exothermic reactions in binary metallic systems are enhanced when the constituents have nanoscale dimensions. Below a threshold value (~200 nm), the reactions self-propagate by the formation of a stable thermal front upon local ignition using an electrical spark or a laser. These nanostructured materials are primarily produced by vacuum deposition and have significant civilian and military applications.

The control of thermal properties of the reactive materials requires an accurate understanding of reaction pathways and their kinetics. For this purpose, the thermal and phase evolution of the Nickel-Aluminum system has been investigated using in-situ x-ray diffraction employing synchrotron radiation and high-speed optical imaging, along with differential scanning calorimetry and pre/post-mortem microstructural characterization. A new numerical model has been developed for simulating the reactions. The results show that observational data is more consistent with sequential diffusion limited growth of multiple phases (Ni_2Al_3 and NiAl), as opposed to a single phase formation step.

Additionally, low-energy ball milling of elemental powders of Nickel and Aluminum was carried out as an alternative method for producing reactive nanostructured materials. The results show that optimally ball-milled powders exhibit very fine lamellar microstructures and can be locally ignited using a spark with no preheating when cold-pressed into pellets, similar to vacuum deposited foils.

Bio:

Dr. Ibrahim Emre Gunduz is a visiting research associate at Northeastern University Boston MA. He holds BS and MS degrees in Mechanical Engineering from Middle East Technical University, Ankara Turkey and a PhD. degree in Mechanical Engineering with Materials Science concentration from Northeastern University, Boston MA. After receiving his PhD in 2006, he started working at the Mechanical and Manufacturing Department at University of Cyprus, Nicosia Cyprus as a Marie Curie research associate, working on reactive nanoscale multilayers and ball-milled energetic powders. Since 2012, he has been working on high-rate mechanical production of nanoparticles and surface nanostructures as precursors to reactive materials and energy applications at Northeastern University.