Daniel Tappmeyer, Chemical Engineering

Year in School: Freshman
Hometown: Warrenton, MO
Faculty Mentor: Dr. Shubhra Gangopadhyay, Electrical & Computer Engineering
Funding Source: Discovery Fellowship Program

Improving the burn-rate of thermite reactions using mesoporous copper-oxide and aluminum nano-particles

Energetic materials are defined as substances in which fuel and oxidizer react to release energy. The amount and rate of energy released by this reaction can be improved by increasing the amount of interfacial contact between fuel and oxidizer. Using a surfactant templating method a mesoporous copper oxide material was prepared. The copper oxide was then mixed with a fuel composed of aluminum nano-particles (80nm) to create an energetic material. When reacted, the burn rate for the self propagating reaction was higher than that of any previously known energetic material. Further improvement can be made by ordering the arrangement of pores, using surfactant templating. In this method surfactant is introduced into a colloidal suspension called sol that will eventually form the copper-oxide gel. Due to the lyphobic and lyophilic interactions in the solution, the surfactant molecules form ordered miceller structure. Using various methods the surfactant can then be removed leaving an ordered network of empty pores in the copper oxide material. When combined with the aluminum nanoparticles, the fuel fills in these pores creating an ordered network of fuel filled pores, greatly increases the amount of interfacial contact between fuel and oxidizer as well as the performance. Although this method has been shown to dramatically improve the performance of this material its applications have been limited by its costs. The primary precursor used in preparing mesoporous copper oxide is copper ethoxide which is extremely costly. The precursor alone cost well over $1600 for every 100g of material prepared. However it has recently been found that similar results can be achieved using much less expensive $CuCl_2$ as a precursor. This material promises to reduce the precursor cost to around $26 per 100g of material produced and greatly expand the number of applications for which this material is suited.