MECHANICAL ENGINEERING

The Department of Mechanical Engineering presents:

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Analysis and application of Silicon Nano-Particles Produced via Continous Flow Non-Thermal Plasmas
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Continuous flow non-thermal plasma reactors are being investigated for their ability to efficiently produce high quality nanoparticles. While many nanomaterials can be produced via continuous flow non-thermal plasma reactors, silicon is of particular interest, due to its abundance and relevance in many energy related fields. Significant gaps still exist in the understanding of the kinetics responsible for particle growth, structural evolution, and surface termination of continuous flow non-thermal plasma reactor produced particles. Particle interaction with plasma radicals results in the heating of the particles, which in turn affects the kinetics of particle growth, structural evolution, and surface termination during synthesis and processing. We have investigated the details of plasma-nanoparticle interaction by using in-flight and in-situ characterization techniques. For the first time, we have measured the temperature of a free-standing particle immersed in a non-equilibrium processing plasma.

In parallel, we have utilized continuous flow non-thermal plasma reactor-produced nanoparticles to create bulk nanostructured materials. The ability to tune size, structure, and surface termination of the continuous flow non-thermal plasma reactor produced nanoparticles allows for significant control of the precursor powders used in the densification processes. Hot pressing processes allow for the production of samples with bulk-like densities while limiting grain growth, allowing for the creation of nanostructured bulk systems. Nanostructured bulk silicon represents an ideal system to study the role of nano-structuring on transport of charge carriers and phonons in bulk materials. Initial results show that small particle and narrow particle size distributions allows for the creation of bulk nanostructured silicon with high ZT values. This system has shown to be relevant for direct conversion of heat into electrical power, but is also a model for the optimization of phonon and charge carrier transport in similar material systems.