Nonthermal plasma synthesis of nanomaterials for renewable energy applications

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Abstract

Nonthermal plasmas offer unique conditions for the synthesis of nanomaterials. Molecular precursors are dissociated by electron impact reactions and the resulting molecular fragments and radicals, many of them charged, nucleate to form clusters and nanocrystals. Energetic surface reactions can heat these initial clusters to temperatures that exceed the gas temperature by hundreds of Kelvin, enabling the synthesis of nanoparticles that require synthesis temperatures too high to be achieved with liquid phase approaches. Moreover, different from colloidal syntheses that utilize organic solvents, plasma synthesis is fully conducted in the gas phase and as such much closer to "green chemistry."

This presentation will discuss the plasma synthesis of a range of nanocrystal materials. As one example, I will discuss luminescent silicon nanocrystals. With the proper surface functionalization, silicon crystals exhibit strong photoluminescence, different from bulk silicon material, and have been studied in applications such as photovoltaics, light emitting devices, and bioimaging. The specific optical properties of silicon nanocrystals with their strong absorption in the blue and emission in the red and near-infrared make them ideal candidates for solar luminescent concentration for photovoltaics integrated into buildings and with agriculture.

Biography:

Uwe Kortshagen is professor of mechanical engineering at the University of Minnesota. He holds the Ronald L. and Janet A. Christenson Chair in Renewable Energy and is a Distinguished McKnight University Professor. His research is in the area of low temperature plasmas physics and chemistry and in the plasma synthesis of nanomaterials and their applications. He earned his Ph.D. in Physics in 1991 from the Ruhr University Bochum, Germany. In 1996, he joined the Department of Mechanical Engineering at the University of Minnesota. He served as Department Head from 2008-2018. He is Fellow of the American Physical Society, the American Society of Mechanical Engineers, the Institute of Physics (UK), and the International Plasma Chemistry Society, and recipient of the 2015 Plasma Prize of the American Vacuum Society. He has directed several multi-investigator research teams, including a recent Army Research Office MURI project on "New Materials from Dusty Plasmas." His work has been published in more than 220 journal articles, including papers in several *Nature* and *Science* family journals.

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