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Microplasmas for gas-phase and liquid-based nanoscale engineering

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Nanomaterials have demonstrated to possess properties that are highly desirable for a wide range of applications. The successful integration of nanomaterials in many application devices strongly depends on our ability to accurately synthesize materials with the necessary properties. In particular, the interplay between quantum confinement effects and surface characteristics is a fundamental aspect that determines the properties and functionalities of nanoparticles that have typical dimensions below ~10 nm. It follows that the synthesis of nanomaterials has to include approaches for surface engineering and tailor the interface characteristics. In this context, atmospheric-pressure microplasmas have shown the capabilities of synthesizing nanomaterials with the required characteristics (*J. Phys.D Appl. Phys.* 43, 2010, 323001; *Carbon* 47, 2009, 2379) and with additional opportunities for surface engineering *(Appl. Phys. Lett.* 97, 2010, 161502; *Adv. Funct. Mater.* 22, 2012, 954). Microplasmas present unique features that differentiate them from other types of plasmas and can provide new synthetic avenues not achievable with other techniques such as chemical synthesis or low-pressure plasmas. Furthermore, the possibility of interfacing microplasmas with liquids has also opened up a range of new plasma-induced chemistries of great interest beyond nanomaterials processing. In this talk I will initially provide an overview of microplasmas properties and capabilities in nanomaterial processing including synthesis and surface engineering of metal, metal-oxides, silicon, silicon alloys and graphene. Microplasma synthesis rates and identified opportunities to achieve a competitive nanofabrication throughput will also be discussed. Finally, results will be presented in relation to the application of the synthesized nanomaterials to energy devices including Li-ion batteries (*Nanotechnology* 19, 2008, 495302) and photovoltaic cells (*J. Phys. Chem. C* 115, 2011, 5084; *Optics Express* 17, 2009, 520).

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