Atmospheric pressure plasmas for energy materials

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Atmospheric pressure plasmas (APPs) have demonstrated unprecedented versatility for the synthesis and processing of nanoscale structures. APPs have shown the possibility of producing thin films, nanostructured coatings, nanoparticles and other complex materials from a variety of precursors that include solid, liquid and gases (e.g. [1-6]). The synthesis of metallic, metal-oxide and semiconducting materials has been demonstrated covering a wide range of elements in the chemical table. Despite research efforts go back only a decade, the quality of the materials produced by APPs is comparable and in some cases superior to results produced with other methods (e.g. wet chemistry, low-pressure plasmas).

In this context, microplasmas at atmospheric pressure have played a major role and have revealed great opportunities for nanoscale engineering, providing unique avenues for accurately tailoring materials properties. While the scale-up of atmospheric pressure microplasmas has not been fully demonstrated yet, progress has been made also in this direction which suggests the possibility of integrating microplasma processes in the fabrication of application devices [7].

In this contribution we will first review the capabilities of APP-based materials synthesis, highlighting the wide range of achievable morphologies and chemical compositions [4]. We will then focus on a range of ultra-small nanocrystals in the quantum confinement regime and explore the corresponding opportunities and challenges. In particular, APP-synthesis of ultra-small metal and metal-oxides nanocrystals will be presented, highlighting opportunities to tailor the band energy structure with various strategies that include quantum confinement, tailored stoichiometry and defect chemistry [8]. The impact of these strategies on photovoltaic and other energy-relevant application will also be discussed [9-12].

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