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(I) Inductively-coupled RF plasma: a versatile tool to synthesize functional materials and advanced ceramics

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Inductively-coupled RF thermal plasma have been known and used in the last three decades for the spheroidization of powders, for the synthesis of single cation ceramics or metallic nanoparticles as well as for the deposition of coatings. This electrodeless plasma produces pure materials at a high throughput. Over the years, the chemical precursors used have evolved from single gas or solid powder injected in inert, reducing or oxidizing gases, to mixtures of reactive gases and powders, to suspensions and solutions axially atomized within the plasma jet. The complexity of the plasma-precursors interactions is increasing and, if the chemically reactive environment of these plasmas have long been considered difficult to probe, the application of optical emission spectroscopy (OES) on molecular bands has opened new possibilities to follow diatomic species, in complement to atomic species. As such, OES should help in understanding and optimizing the synthesis of functional materials and advanced ceramics in RF thermal plasmas.

In this presentation, recent developments undertaken at the Université de Sherbrooke for the RF thermal plasma synthesis of active cathode and anode materials for lithium batteries will be presented. In particular, solid precursors were used to synthesize Li2S and silicon nanowires, whereas solutions precursors were chosen for the synthesis of LiFePO4.

In another field of application, tantalum ethoxide was put into sol, mixed with a solution of Ba and Mg salts, and injected in an oxidative plasma jet to form a complex, high melting point Ba(Mg2/3Ta1/3)O3 perovskite with vertical grains to be used as thermal barrier coatings. The synthesis of a simpler BaTiO3 perovskite was investigated using OES.

As a final example, the synthesis of graphene nanoflakes and other carbonaceous structures will be discussed in relation to operating parameters such as the C : H ratio and pressure, as well as to OES measurements.

Author: Prof. VEILLEUX, Jocelyn (Université de Sherbrooke)

Presenter: Prof. VEILLEUX, Jocelyn (Université de Sherbrooke)

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