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Inductively coupled thermal plasma - a versatile tool for the processing of powders

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Among the thermal plasmas, the inductively coupled ones present the advantage of large vol-ume and moderate velocity making this technique well suitable for the controlled evaporation or melting of large quantities of particulate materials. Thus, ICP is industrially used for the synthesis of nanoparticles, or for the spheroidisation and densification of microscale powders. The nanoparticle synthesis involves the formation of a supersaturated phase and its subsequent rapid condensation. A high flexibility is provided by this technique regarding the feedstock. A most common production route is the evaporation of commercially available and easy to handle microscale particles, but liquid and even gases can also be used as starting materials. The control of the thermal history of these precursors is of prime importance for guaranteeing the quality of the product. Indeed, strong temperature gradients in the plasma may lead to different evaporation rates, particle sizes or even different compositions. An *in-situ* diagnostic is then required for understanding and controlling the process. Due to the dusty and high-temperature environment, optical techniques are an interesting approach giving valuable information about the plasma state, the particle-plasma interaction and even about some na-noparticle properties. Additionally, the injection of a secondary material allows the function-alization of the produced nanoparticles in-situ and in-flight offer new potentials for ICP pro-cessing. More recently the fast growing of additive manufacturing induced a specific interest in powder spheroidisation for making powders more flowable. Indeed, in the powder bed ap-proach, a powder layer is deposited before the laser or the electron beam is writing a structure. A defect in the powder layer arrangement may induce a defect in the additive manufactured the part. Therefore, highly flowable powders are required. By adapting the inductive plasma process parameters, a full melting of the starting powder without extensive evaporation can be achieved. The melt particles form then dense spheres with improved flowability upon cooling. Empa is investigating thermal plasmas and especially ICP since more than 15 years. A short review of the activities will be presented here.

Biography

Marc Leparoux is head of the group of nanoparticles and nanocomposites at the laboratory for advanced materials processing at Empa. He received his Magistère in materials science and a DEA in solid chemistry in 1992 at University of Rennes. He completed his PhD in physical chemistry in 1995 from University of Orléans in France. He then worked on high temperature process monitoring at Fraunhofer institute for material and beam technology (IWS) in Dresden, Germany. He joined Empa in 2001 where he developed the activities on thermal plasma synthesis of nanoparticles. Particularly, his interest is in gas phase process un-derstanding and improvement based on *in-situ* characterization using various optical methods, among them emission and absorption spectroscopy as well as high speed imaging. These techniques are presently also used in other plasma induced processes as for instance in laser metal welding and more recently in laser metal deposition an additive manufacturing process.

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