Modulated Induction Thermal Plasmas and their Application to High-Throughput Nanopowder Synthesis

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The inductively coupled thermal plasma (ICTP) is characterized by high gas temperature, high radical density with high power density and no contamination. From these characteristics, the ICTP is widely used for materials processing such as plasma spray coating, nanoparticle syntheses. However, it has been difficult to control the gas temperature and then chemical reactions in the ICTP in detail by the conventional methods. To enhance its controllability, we have developed various types of modulated induction thermal plasma systems at rated power of 30 kW [1]. The modulated induction thermal plasma is sustained by the coil current modulated into different waveforms. Such the modulation enables us to control the gas temperature and chemical reaction fields in the ICTP. Recently, we developed a unique and original method for synthesizing nanoparticles using the pulse-modulated induction thermal plasma (PMITP) combined with time-controlled feeding of feedstock (TCFF) [2,3]. In this method, feedstock powder is injected intermittently and synchronously with higher coil current duration of the PMITP. This PMITP-TCFF method provides efficient evaporation of feedstock and efficient nucleation of nanoparticles [4]. This method offers nanoparticle synthesis with a high production rate more than 400 g/h for Al^{3+}-doped TiO_2 nanoparticles, and 720 g/h for Fe^{3+}-doped TiO_2 nanoparticles.

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