Phase selective laser-induced breakdown spectroscopy (PS-LIBS) diagnostics on the doping mechanism of mixed metal oxide nanoparticles in flame synthesis

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Keywords: PS-LIBS, doping mechanism, nanoparticles, flame synthesis
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A novel laser diagnostic method, phase-selective laser-induced breakdown spectroscopy (PS-LIBS), has been utilized for *in situ* diagnostic of the bandgap variation of mixed metal oxide nanoparticles. In PS-LIBS diagnostic process, matter in particle phase is excited into localized nano-sized plasma by nanosecond laser, while matter in gas-phase is kept unexcited, based on the selectivity of breakdown thresholds between particle phase and gas phase (Zhang *et al.* 2014, Zhang *et al.* 2015). The physical nature of this phenomenon is that the electrons are excited to the conduction band during one- or multi-photon excitation, then ablate the crystal structure and finally lead to the formation of nano-sized plasma (Ren *et al.* 2015). Therefore the signal intensity of PS-LIBS is significantly influenced by the bandgap of particles and can be applied in diagnostic of the doping mechanism of flame-made nanoparticles. As a demonstration, the V-doped TiO_2 flame synthesis system is studied in this work.

Figure 1 illustrates the atomic emission of Ti at different positions above the burner outlet with and without doping of V. The signal intensity increases with the height above burner, which indicates a clear gas-to-particle conversion process in vapour-fed aerosol flame synthesis. Moreover, the atomic emission of Ti is significantly strengthened by doping V due to the lower bandgap of V-doped TiO_2 particles compared with that of pure TiO_2 particles. In a word, PS-LIBS clearly indicate that bandgap of flame-synthesized nanoparticles decreases with (i) the increase of particle size in the gas-cluster-particle conversion process and (ii) doping of V in the crystal structure of TiO_2.

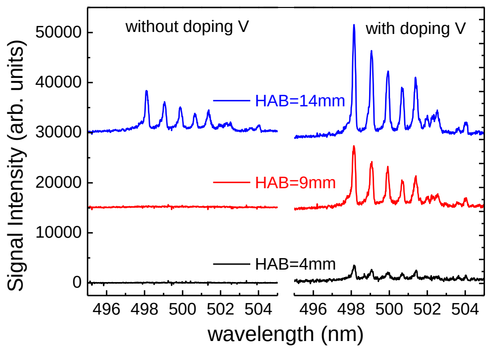

Figure 1. Atomic emission of Ti at the different positions, i.e. different height above the burner outlet (HAB), at conditions with and without doping of V.

This work is mainly funded by the National Natural Science Funds of China (No. 51176094) and by the National Key Basic Research and Development Program (No. 2013CB228506).

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