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Optical Diagnostics of Nanopowder Processed in Liquid Plasmas

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Plasma in liquid phase has attracted great attention in the last few years by the wide domain of applications in material processing, decomposition of organic and inorganic chemical compounds and sterilization of water. The plasma in liquid is characterized by three main regions which interact each - other during the plasma operation: the liquid phase, which supply the plasma gas phase with various chemical compounds and ions, the plasma in the gas phase at atmospheric pressure and the interface between these two regions. The most complex region, but extremely interesting from the fundamental, chemical and physical processes which occur here, is the boundary between the liquid phase and the plasma gas phase.

In our laboratory, plasma in liquid which behaves as a glow discharge type, is generated by using a bipolar pulsed power supply, with variable pulse width, in the range of 0.5～10 μs and 10 to 30 kHz repetition rate. Plasma in water and other different solutions was characterized by electrical and optical measurements. Strong emissions of OH and H radicals dominate the optical spectra. Generally water with 500 μS/cm conductivity has a breakdown voltage around 2 kV, depending on the pulse width and the repetition rate of the power supply. The characteristics of the plasma initiated in ultra-pure water between pairs of different materials used for electrodes (W and Ta) were investigated by the time-resolved optical emission and the broad-band absorption spectroscopy. The deexcitation processes of the reactive species formed in the water plasma depend on the electrode material, but have been independent on the polarity of the applied voltage pulses. Recently, Coherent anti-Stokes Raman Spectroscopy method was employed to investigate the chemistry in the liquid phase and at the interface between the gas and the liquid phases of the solution plasma system.

The use of the solution plasma allows rapid fabrication of the metal nanoparticles without being necessary the addition of different reducing agents, because plasma in the liquid phase provides a reaction field with a highly excited energy radicals. We successfully synthesized gold nanoparticles using a glow discharge in aqueous solution. Nanoparticles with an average size of less than 10 nm were obtained using chlorauric acid solutions as the metal source. Carbon/Pt hybrid nanostructures

have been obtained by treating carbon balls, synthesized in a CVD chamber, with hexachloro- platinum acid in a solution plasma system. The solution plasma was successfully used to remove the template remained after the mesoporous silica synthesis. Surface functionalization of the carbon structures and the silica surface with different chemical groups and nanoparticles, was also performed by processing these materials in the liquid plasma.

Keywords: liquid plasma, nanopowder, Optical diagnostic