Size-Controlled and Optical Properties of Platinum Nanoparticles by Gamma Radiolytic Synthesis

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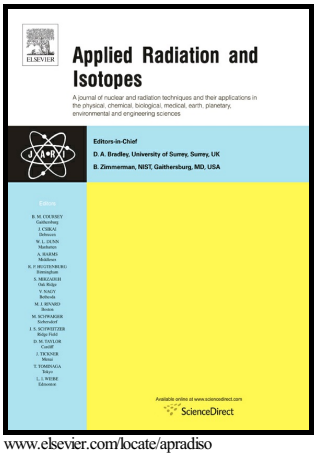

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Size-Controlled and Optical Properties of Platinum Nanoparticles by Gamma Radiolytic Synthesis

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Abstract

Gamma radiolytic synthesis was used to produce size-controlled spherical platinum nanoparticles from an aqueous solution containing platinum tetraammine and polyvinyl pyrrolidone. The structural characterizations were performed using X-ray diffraction, and transmission electron microscopy. The transmission electron microscopy was used to determine the average particle diameter, which decreased from 4.4 nm at 80 kGy to 2.8 nm at 120 kGy. The UV-visible absorption spectrum was measured and found that platinum nanoparticles exhibit two steady absorption maxima in UV regions due to plasmonic excitation of conduction electrons, which blue shifted to lower wavelengths with a decrease in particle size. We consider the conduction electrons of platinum nanoparticles to follow Thomas-Fermi-Dirac-Weizsacker atomic model that they are not entirely free but weakly bounded to particles at lower-energy states {n=5, l=2 or 5d} and {n=6, l=0 or 6s}, which upon receiving UV photon energy the electrons make intra-band quantum excitations to higher-energy states allowed by the principles of quantum number that results the absorption maxima. We found an excellent agreement between the experimental and theoretical results, which suggest that the optical absorption of metal nanoparticles could be fundamentally described by a quantum mechanical interpretation, which could be more relevant to photo-catalysis and heterogenous catalysis.