Colloid Science and Photolitography Methods of Fabrication of Metal Nanoparticle Catalysts in 2D and 3D Structures. Challenges of Nucleation, Growth, Particle Shape and Size Control

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Metal (Pt, Rh) and bimetallic nanoparticles in the 1-10 nm size range were synthesized and capped with polymers or inorganic shells to avoid their segregation. Strategies of heterogeneous nucleation using a seed and altering monomer concentration lead to monodisperse nanoparticles with controlled shape and size. Characterizations using a combination of electron microscopy, XRD, SAXS, AFM, physisorption and chemisorption are carried out. Two-dimensional films of nanoparticles using the Langmuir-Blodgett techniques are prepared on oxide supports. 3-dimensional distribution of the nanoparticles, using mesoporous SBA-15 support is produced. Particle size dependences of reaction selectivity were detected for cyclohexane dehydrogenation, ethane hydrogenolysis and crotonaldehyde hydrogenation were detected and will be discussed.

Photolitography is used to fabricate catalytic nanodiodes composed of 5 nm Pt films on TiO_2 and GaN semiconductors. Electron current (chemicurrent), which is proportional to the catalytic turnover rate is detected during the CO/O_2 and H_2/O_2 reactions. These results may explain the unusual catalytic activity at certain oxide-metal interfaces.