A three-dimensional analysis of Au-silica core-shell nanoparticles using medium energy ion scattering

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The medium energy ion scattering (MEIS) facility at the IIAA Huddersfield has been used for the analysis of a monolayer of Au-silica core-shell nanoparticles deposited on Si substrate. Both spherical and rod shape particles were investigated and the spectra produced by 100 keV He^+ ions scattered through angles of 90º and 125º were compared with the results of RBS-MAST [1] simulations performed on artificial 3D model cells containing the nanoparticles. The thickness of the silica shell, the diameter of the Au spheres, and the diameter and length of the Au nano-rods were determined from best fits of the measured set of MEIS spectra.

In addition, the effect of ion irradiation on the silica shell and gold core was monitored by MEIS measurements in conjunction with RBS-MAST simulations. Ion bombardment was performed under largely different conditions, i.e., by 30 keV Ar^+, 150 keV Fe^+, or 2.8 MeV N^+ ions in the dose range of 2×10^{15} - 2×10^{16} cm^{-2}. Significant changes in the particle geometry can be observed due to ion beam-induced sputtering and recoil effects, the significance of which was estimated from full-cascade SRIM simulations.

Rutherford backscattering spectrometry (RBS), Field emission scanning electron microscopy (FESEM), and Atomic Force Microscopy (AFM) techniques have been applied as complementary characterization tools to monitor the amount of gold and surface morphology on the un-irradiated and irradiated sample areas. We show that MEIS can yield spatial information on the geometrical changes of particulate systems at the nanometre scale.

References.

[1] Z. Hajnal, E. Szilágyi, F. Pászti, G. Battistig, Nucl. Instr. and Meth. B 118 (1996) p. 617