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Deposition of Gold and Silver Colloid Monolayers on Dendrimer-Modified Silicon Oxide Surfaces

The modification of glass, silicon and ITO glass surfaces with starburst dendrimers (see *Gold Bull.*, 1996, **29**, 16), has enabled research workers in Freiburg, Germany and Los Alamos National Laboratory, USA to deposit gold and silver colloid monolayers onto these surfaces. Georg Bar, Shai Rubin, Russell W. Cutts, Thomas N. Taylor and Thomas A. Zawodzinski (*Langmuir*, 1996, **12**, 1172) have described a preparative method which is very simple, requiring only two steps, i.e. immersing the substrate into the dendrimer solution and deposition of colloids. The resulting transparent films are stable for at least several weeks.

The structure of the resulting films has been investigated using X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), and atomic force microscopy (AFM), and this has shown that the size distribution, particle separation, and degree of colloid monolayer formation can readily be controlled. The optical properties were examined using UV-visible spectroscopy and surface-enhanced Raman scattering (SERS).

Gold and silver colloids ranging from 15 to 80 nm in particle diameter have been deposited onto the dendrimer-modified surfaces. XPS data show that the dendrimers spontaneously adsorb

on to various silicon oxide surfaces - it is likely that some amine groups are protonated under the conditions of these experiments, thus imparting a net positive charge to the dendrimer layer. The driving force for adsorption of the dendrimers onto the surface then arises from the interaction between the positively charged protonated amino groups and the hydrophilic silicon oxide surface.

SEM and AFM showed that the noble metal colloid particles are well isolated and confined to a single layer, and that aggregation does not occur on the surface. Particle size, inter-particle spacing, and surface coverage can be controlled by varying the colloid concentration in solution and the immersion time of the substrates, resulting in tunable physical and chemical properties of the films. UV-visible spectroscopic data show that the microstructure directly controls the optical properties of the layer. The SERS studies are being used to elucidate the relationship between the nanoscale architecture and the optical properties of the films. This new technology could also have applications in control of particle size in the preparation of supported gold catalysts.

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