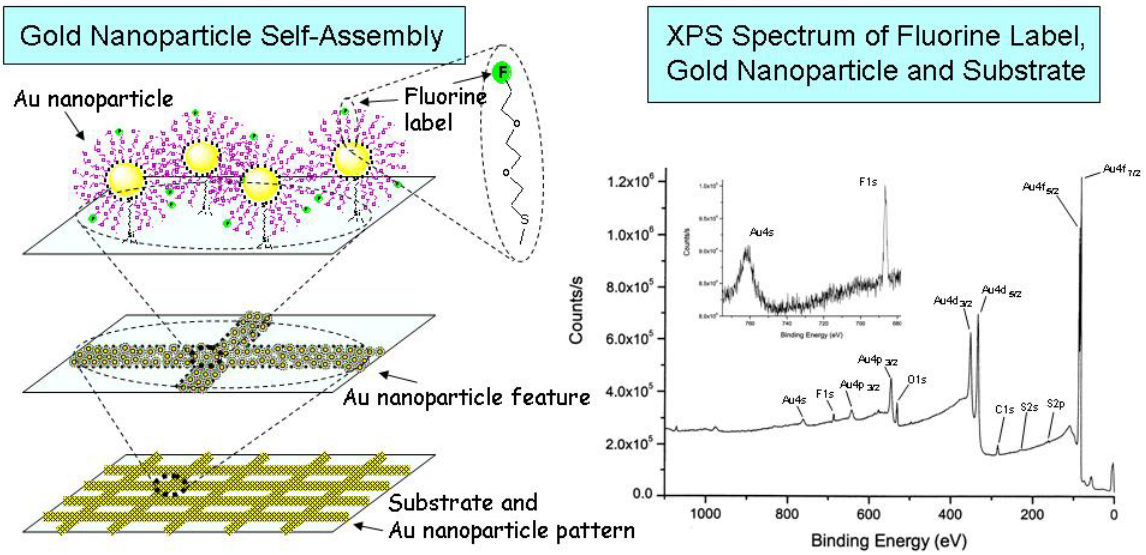
Molecular Labeling Diagnostic for Self-Assembled Nano-Electronics

A diagnostic for macroscopic measurement of the number density of metal nanoparticles self-assembled onto an opaque substrate or template has been demonstrated. It employs a fluorine atom as a substituent onto a molecular ligand molecule that encapsulates the metal nanoparticles.

The self-assembly of metal nanoparticles into nanoscale patterns on surfaces and templates is a process that, when reliable, will be employed for the fabrication of nanoelectronic devices. As electronics scale in feature size from the micron to nanometer domain, feature fabrication will require chemical self-assembly to replace deep UV lithography. This molecular labeling diagnostic can characterize the packing density of self-assembled metal nanoparticles over small or large areal surfaces. This is important both as a developmental tool in working out details of a self-assembly procedure and as a quality control diagnostic to insure that a deposition of particles has sufficient density to act as a continuum.



The expanded scale graphic depicts a patterned deposition of self-assembled gold nanoparticles followed by a depiction of their packing into a feature, and a further expansion depicting the chemical bonding to the substrate and the incorporated fluorine label in a molecule of the ligand shell. Fluorine has a high sensitivity factor in XPS and is not a frequently encountered impurity. In the XPS spectrum of a self-assembled deposition of gold nanoparticles, peaks corresponding to the fluorine label, gold nanoparticle and substrate can be quantitatively measured and used to determine the nanoparticle packing density from millimeter to submicron spot sizes.

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Contributing Agency: DoD / NRL