Extremely Strong Enhancement of Optical Absorbance from Ionic Self-Assembled Monolayer thin films of nanocluster metal and polymer dye

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The enhancement of surface phenomena due to microscopic surface roughness has caused a great deal of excitement during the past 2 decades. Examples are surface enhanced Raman scattering, surface-enhanced second harmonic generation, and enhanced photoemission from metal particles. Despite substantial progress in the past, it is still not possible to form thin films in a way that ideally emulates the desired synthesis procedure of starting off with a bare surface, and continuously varying the molecular and metal cluster coverage. In the article, we describe a method for the preparation of multilayer thin films alternately composed of Pt nanoclusters and polymer dye molecules by a novel ionic self-assembled monolayer (ISAM) process. It is demonstrated that this new process can be successfully performed with ultrafine Pt (<1 nm) and ultrathin layers (<1 nm) of polymer dye molecules. The UV-vis absobance intensity of the ISAM Pt/dye films was found to rapidly increase as more layers were deposited. Several hundreds of times of enhancement of light absorbance are first observed due to the unique multilayer architecture and molecular structures, as well as nanoscopic roughness effects. This large and unusual enhancement effects are attributed to both the charge-transfer mechanism and very large local fields and collective phenomena near the surface and at the interfacial layers of the small metal cluster/dye electrolytes.