Stabilization of Metal Nanoparticle Films on Glass Surfaces Using Ultrathin Silica Coating

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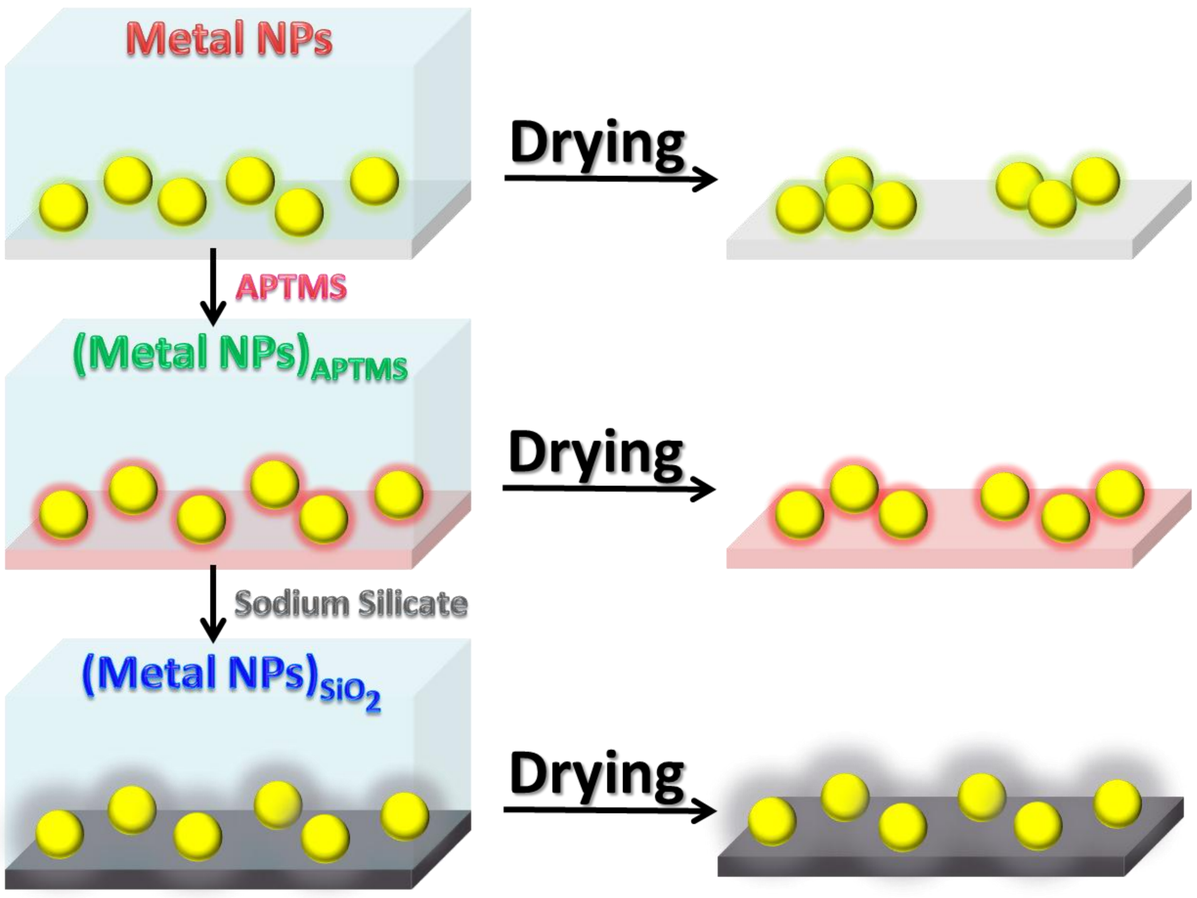
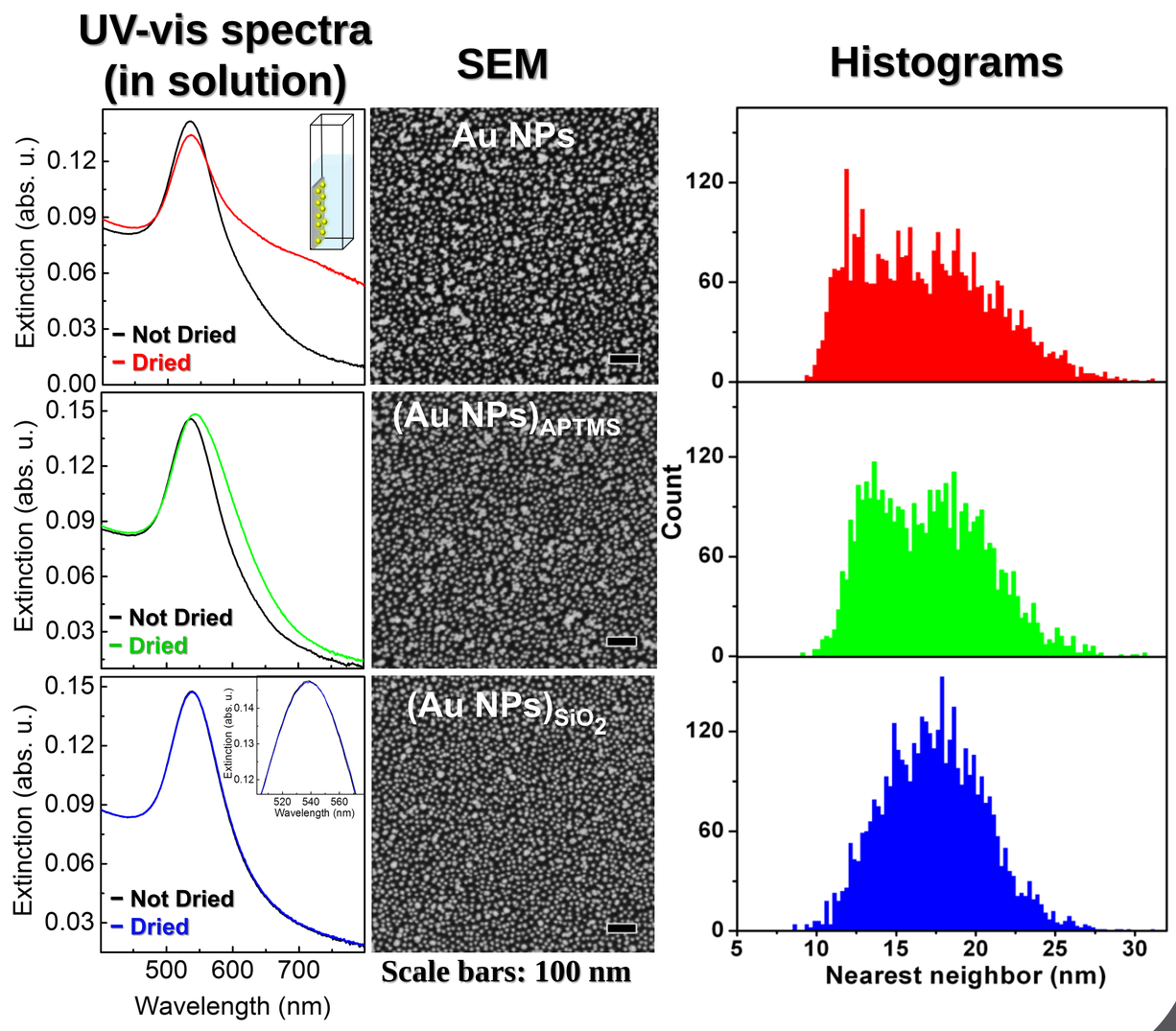
Abstract: A major concern in the formation of metal nanoparticle (NP) assemblies on surfaces is a commonly observed instability, i.e., the NPs tend to undergo aggregation upon removal from the solution and drying, expressed as a drastic change in the localized surface plasmon resonance (LSPR) extinction band. Since various imaging modes and applications require dried NP films, preservation of the film initial (wet) morphology and optical properties upon drying are highly desirable. The latter is achieved in the present work by introducing a convenient and generally-applicable method for preventing NP aggregation upon drying while preserving the original film morphology and optical response. Stabilization of Au and Ag NP monolayers toward drying is accomplished by coating the immobilized NPs with an ultrathin (3.0–3.5 nm) silica layer, deposited using a sol-gel reaction carried out on an intermediate self-assembled 3-aminopropyl trimethoxysilane (APTMS) layer. The thin silica coating prevents NP aggregation and maintains the initial NP film morphology and LSPR response during several cycles of drying and immersion in water. It is shown that the silica-coated NP films (Metal NPs)$_{SiO_2}$ retain their capability to be used as effective LSPR transducers.

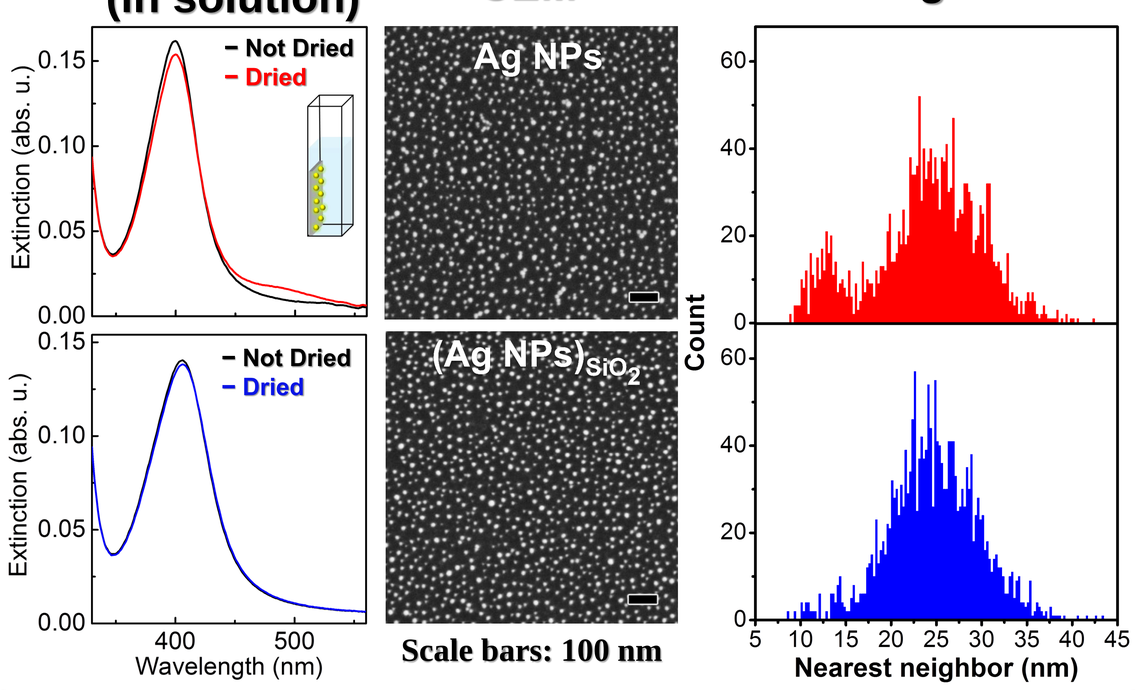
Scheme



The System with Citrate-Capped Au NPs

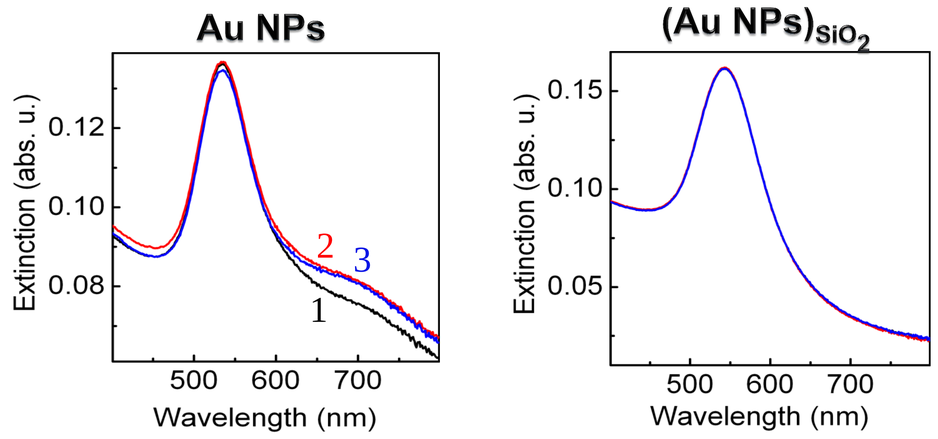


The System with Phosphonate-Capped Ag NPs



Stability of the Au NP Films: Optical Response

Transmission UV-vis spectra after three consecutive cycles of drying under N_2 and immersion in water

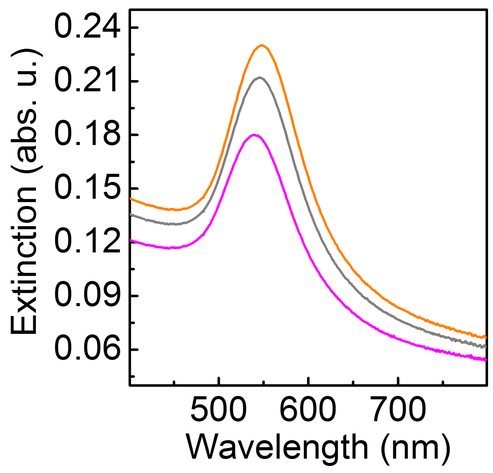


Summary

- **Stabilization of metal (Au, Ag) NP monolayers toward drying is accomplished by coating the adsorbed NPs with an ultrathin silica layer, deposited using a sol-gel reaction carried out on an intermediate self-assembled aminosilane layer.**
- **The thin silica coating prevents NP aggregation and maintains the initial (wet) NP film morphology and LSPR response during several cycles of drying and immersion in water.**
- **The silica-coated NP films can be used as effective LSPR transducers in sensing applications.**

Silica-coated Au NP Film as an LSPR Transducer in Simulated Sensing

Transmission UV-vis spectra of a SiO_2-coated Au NP film gradually coated with polyelectrolyte layers



References:

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