Tunable Plasmonics of Gold Nanoaggregates on a Polymer Membrane

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We will describe experiments in which the interstitial gaps between gold nanoaggregates have been controllably varied, or 'tuned'. This method provides a pathway to investigate plasmonics, surface-enhanced vibrational spectroscopy, localised electromagnetic field distributions, and so on. Colloidal nanoparticles were self-assembled on elastomeric polyurethane membranes as N-particle monolayer aggregates, where N is small. The reversible nanoscale stretching properties of such membranes have been studied previously for application to tunable nanopores [1]. When the underlying elastomeric membrane is reversibly stretched and relaxed, interstitial gaps between immobilized nanoaggregates are influenced. Preliminary surface-enhanced Raman scattering (SERS) measurements have shown that the nanoaggregates are highly SERS-active [4], and the SERS intensity of a particular molecular band was observed to decrease with increasing applied strain, in agreement with a theoretical prediction. Other attempts to directly study the dependence of plasmonics on interstitial gaps have been reported [2,3], but full control over tuning of nanoscale gaps has not been achieved.

Our approach uses colloid-based gold nanoparticles without surface modification. Scanning electron microscopy and atomic force microscopy (AFM) have confirmed that the self-assembled aggregates are monolayers, often with tiny interstitial gaps (Fig. (a)). AFM scans, carried out carefully at variable membrane stretch (Fig. (b)-(d)), have been used for topographical confirmation. For example, the interparticle gap for a dimer increases with increasing mechanical strain (Fig. (e)).

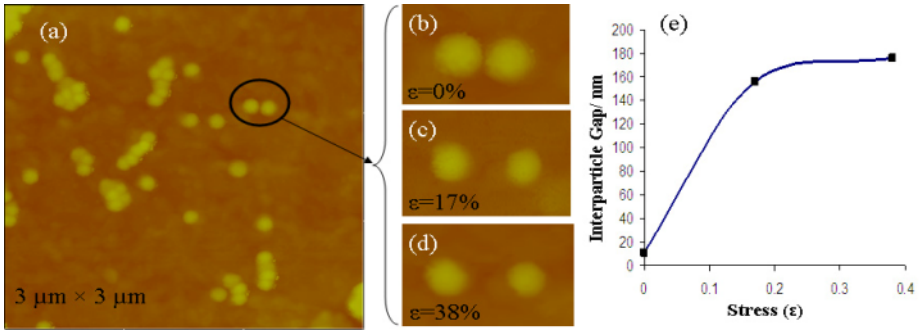

Figure: AFM images of (a) gold nanoaggregates on an elastomeric membrane, and (b)-(d) gap variation with increasing strain for a particular dimer circled in (a). (e) shows the relation between interparticle gap and applied strain.

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