Shape memory effect on plasmon coupling in shape memory polymers with embedded gold nanoparticles

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When Au nanoparticles (NPs) are dispersed in polymers, their organization determines the interparticle distances and extent of plasmon coupling. In this study, plasmon coupling of spherical Au NPs with an average diameter of 16 nm was investigated in shape memory polymer (SMP) films before and after mechanical stretching and then after thermally driving shape recovery. The Au NPs initially form clusters within the SMP. During stretching, a significant polarization-dependent response develops, where the optical absorbance maximum corresponding to the surface plasmon resonance is redshifted by up to 21 nm and blueshifted by up to 13 nm for polarization parallel and perpendicular to the stretching direction, respectively. This result can be explained by non-uniform stretching on the nanoscale, where clustering is enhanced along the shear direction as Au NPs are pulled into each other during stretching, while coupling perpendicular to the to the stretching direction is reduced despite the Poisson effect. If the sample is not heated during stretching, the polarization dependence vanishes after shape recovery, while polarization-dependent optical properties remain for samples heated during stretching. Simulations of the polarized optical responses of Au NP dimers at different distances are consistent with experimental results and allow estimation of the average interparticle spacings.

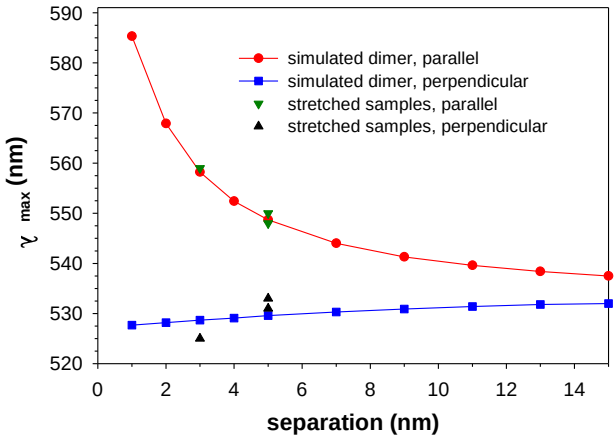

Figure 1. Maximum wavelength from optical absorbance spectra vs. interparticle surface-to-surface separation for dimers of Au NPs from simulations with data points for maximum wavelengths for three experimental samples added to match the simulations, thereby estimating the average interparticle distance.

[1] S R Mishra, J B Tracy, *ACS Appl. Nano Mater.* **1** (2018), 3063.

Acknowledgement: The authors acknowledge funding from the National Science Foundation (CMMI-1663416 and CBET 1803830) and National Institutes of Health (R21 HL 130901).