

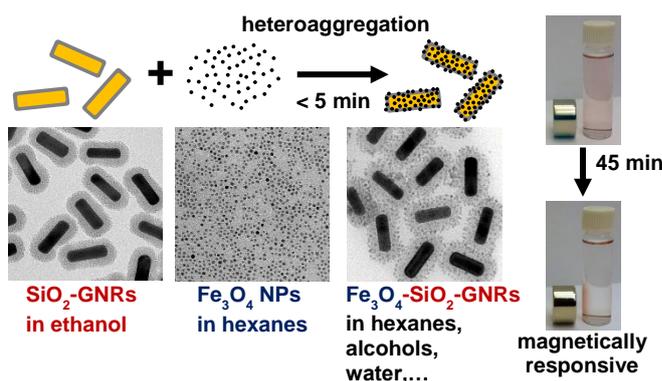
## Heteroaggregation Approach for Depositing Magnetite Nanoparticles onto Silica-Overcoated Gold Nanorods

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Hydrophobic, oleylamine-stabilized magnetite nanoparticles ( $\text{Fe}_3\text{O}_4$  NPs) dispersed in hexanes can assemble into dense coatings on the surface of silica-overcoated gold nanorods ( $\text{SiO}_2$ -GNRs) dispersed in ethanol by mixing. In this non-aqueous heteroaggregation process,  $\text{Fe}_3\text{O}_4$  NPs are destabilized when ethanol is added, resulting in core/satellite  $\text{Fe}_3\text{O}_4$ - $\text{SiO}_2$ -GNRs within a few minutes. The composition of the solvent mixture allows tuning of the polarity and driving forces toward aggregation. At the optimal 2:1 volume ratio of hexanes:ethanol, heteroaggregation to form  $\text{Fe}_3\text{O}_4$ - $\text{SiO}_2$ -GNRs occurs quickly, while avoiding homoaggregation of  $\text{Fe}_3\text{O}_4$  NPs or  $\text{SiO}_2$ -GNRs.  $\text{Fe}_3\text{O}_4$ - $\text{SiO}_2$ -GNRs retain the longitudinal surface plasmon resonance of the gold nanorod cores and are magnetically responsive and separable. The  $\text{Fe}_3\text{O}_4$  NPs remain bound on the surface of the  $\text{Fe}_3\text{O}_4$ - $\text{SiO}_2$ -GNRs during multiple cycles of magnetic extraction and redispersion. Oleylamine ligands on the  $\text{Fe}_3\text{O}_4$  NPs render the  $\text{Fe}_3\text{O}_4$ - $\text{SiO}_2$ -GNRs dispersible in non-polar solvents. Functionalization of the outer  $\text{Fe}_3\text{O}_4$  surface with poly(ethylene glycol) catechol (PEG-catechol) for PEGylation results in PEG- $\text{Fe}_3\text{O}_4$ - $\text{SiO}_2$ -GNRs that disperse in water. In comparison with seeded growth or use of molecular crosslinkers to form multifunctional nanoparticles, heteroaggregation approaches are potentially quite general, simple, and efficient. The ability to continuously adjust the solvent polarity is expected to allow tuning of the heteroaggregation process for many different types and sizes of NPs [1].



**Figure 1.** Mixing  $\text{SiO}_2$ -GNRs (left) and  $\text{Fe}_3\text{O}_4$  NPs (center) yields  $\text{Fe}_3\text{O}_4$ - $\text{SiO}_2$ -GNRs (right), which are magnetically responsive [1].

[1] B S Chapman et al., *Chem. Mater.* **29** (2017) 10362.

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