Anisotropy under soft confinement: A new fate for gold nanoparticles?

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The unique properties of confined molecules are dictated by the architecture of their host environment [1] . Traditionally, these systems are classified by their dimensionality and structural rigidity, with soft environments, such as reverse micelles (RMs), serving as versatile nanoreactors [2] . Within these frameworks, nanoconfined water plays a critical role, as its physicochemical properties differ significantly from the bulk phase [3] , directly influencing nucleation and growth. Despite numerous studies using isotropic soft systems to control nanoparticle formation, significant discrepancies remain regarding the underlying mechanisms in more complex geometries [4] . In this work, we utilize reverse wormlike micelles (RWLMs) composed of lecithin, cyclohexane, and water to investigate how structural anisotropy and the state of confined water influence chemical reactivity (Fig. 1A) [5,6] . The reduction of gold nanoparticles (AuNPs) served as a high-sensitivity structural probe, as their morphology and optical response provide a direct "fingerprint" of the nanoreactor's internal constraints and the evolution of the reaction (Fig. 1B). By comparing identical reaction conditions in both anisotropic (RWLMs) and isotropic (RMs) environments, we observed that modulating the nanoreactor's morphology and reactant concentration profoundly alters both reaction kinetics and AuNP shape. In summary, our findings demonstrate that anisotropy could be a decisive factor in dictating structural evolution, offering a new perspective on the behavior of matter under confinement. Looking forward, this work opens possibilities for fine-tuning the optical properties of gold nanostructures by precisely engineering the architecture of their soft host environments.

Keywords:
Soft confinement. Reverse wormlike micelles. Structural anisotropy. Gold nanoparticles.

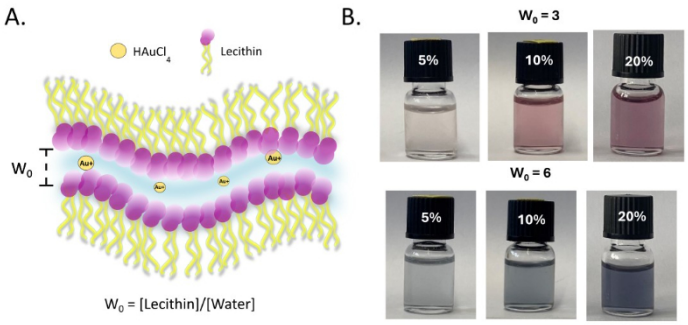

Figure 1. A) Schematic representation of gold ions confined within reverse wormlike micelles. B) Photograph of reverse wormlike micelle systems after reaction, illustrating the color change associated with different gold nanoparticles produced at varying water content (W0).

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