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Templated Synthesis of Heterostructured Nanocomposites toward Self-assembled Functional Materials

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Abstract

2D semiconducting nanomaterials hold promise for advances in energy storage, solar energy harvesting, and photocatalysis. For example, the absorbed photon to current efficiencies of 2D semiconductors such as MoS_2 decreases as the number of layers increases beyond a single layer. However, colloidal approaches toward exfoliated 2D nanomaterials generally lead to defects and aggregation in solvents. Layered silicate clays are discoidal particles with a high cation-exchange capacity at the faces, a feature that allows facile modification with surfactants. In this talk, strategies toward modifying this interface in order to template the growth of inorganic nanomaterials are presented. Initial studies on templating the growth of gold nanoparticles [1] have led to a focused effort towards the colloidal synthesis of heterostructured semiconducting materials such as MoS_2 [2] and In_2S_3. These nanohybrids show promising enhancements in catalytic and photophysical properties, paving the way for further studies on other materials and template particles. Furthermore, the potential of layered silicate clay-based hybrids for self-assembly into nacre-like functional materials is discussed[3]. In addition to developing low-cost materials with improved properties, we provide a novel avenue for the rational design of nanocomposites and heterostructured nanomaterials for myriad applications.

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[2] Jatav, S., Furlan, K. P., Liu, J., Hill, E. H. ACS Appl. Mater. Int. 2020, 12(17), 19813-19822
[3] Hill, E.H., Hanske, C., Johnson, A., Yate, L., Jelitto, H., Schneider, G.A., Liz-Marzán, L.M. Langmuir 2017, *33*(35), 8774-8783.