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2D Nanomaterials: Fundamentals and Applications †

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Abstract: 2D nanomaterials are an exciting class of materials in themselves amongst the nanomaterials. The sheer nature of these materials being confined along one dimension and with a huge surface area in the other two dimensions leads to very exciting properties. The talk is about two classes of 2D materials – semiconductor nanoplatelets and transition metal dichalcogenides.

Semiconductor nanoplatelets are well-defined structures with confinement along with the thickness of these platelets. For example, CdSe can be made with precisely a few monolayers with superb control over the optical properties. The heterostructures of these materials offer immense possibilities in optoelectronic applications.

Transition metal dichalcogenide (TMD) nanosheets with defect-rich and vertically aligned edges are advantageous for various catalytic applications. Synthesis of TMDs using colloidal techniques opens various possibilities to tune the electronic and optical properties of these 2D materials. As an example, we choose $MoSe_2$ nanosheets that have plenty of defects. The defect sites are responsible for adsorption on the surface, thereby yielding excellent electrocatalytic hydrogen evolution and other catalytic activities on the surface. Further, these defects can be employed as seeding points to growing other materials on them. Cu_2S in these defect sites leads to a Type-II semiconductor heterojunction that allows for charge separation, and therefore the $MoSe_2$-Cu_2S forms a superior material for the generation of photocurrent. Now even heterojunctions of $MoSe_2$, a hexagonal crystal with $CsPbBr_3$ – a perovskite, have been enabled by using a linker molecule 4 – amino thiophenol. Enhanced photocurrents are obtained with such a nanoheterostructure. This methodology further opens up avenues for forming heterostructures with large lattice mismatches and can be of great potential use.

Keywords: Nanomaterials; semiconductor nanoplatelets; transition metal dichalcogenides (List three to ten pertinent keywords specific to the article; yet reasonably common within the subject discipline.)

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Conflicts of Interest

The authors declare no conflict of interest.