2D polymers synthesis and 2D-polymer-based vdW heterostructure fabrication at air-water interface

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A 2D polymer is a sheet-like monomolecular macromolecule consisting of laterally connected repeat units with end groups along all edges. Ever since Hermann Staudinger discovered linear polymers in 1920, synthetic scientists have dreamed of extending the polymerization into 2D. From the application perspective, given the enormous chemical and structural diversity of the building blocks (i.e., monomers), 2D polymers hold great promise in the rational material design tailored for next-generation applications, such as membrane separation, electronics, optical devices, energy storage, and conversion, etc. However, despite the tremendous developments in synthetic chemistry over the last century, the bottom-up synthesis of 2D polymers with defined structures remains a formidable task.

Since 2014, we have started to pursue this intriguing yet challenging goal. We innovatively developed two novel synthetic routes: One is to use surfactant monolayer as a soft template to guide the supramolecular organization of monomers and the subsequent 2D polymerization at an air-water interface. This synthetic methodology is now termed surfactant-monolayer-assistant interfacial synthesis (SMAIS). Using the SMAIS method, we achieved the controlled synthesis of highly-crystalline few-layer 2D polyimide and polyamide for the first time. The other method is Langmuir–Blodgett technique to synthesize monolayer 2D polymers. Furthermore, the 2D polymer film can be fabricated with graphene via cation-π interaction to prepare 2DPI-Graphene hybrid materials. This material shows ultra-fast (~60 fs) charge transfer from protonated 2DPI to graphene under UV radiation, comparable with the best records of inorganic vdWH materials.

References

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