Self-assembly of light-harvesting crystalline nanosheets in aqueous media

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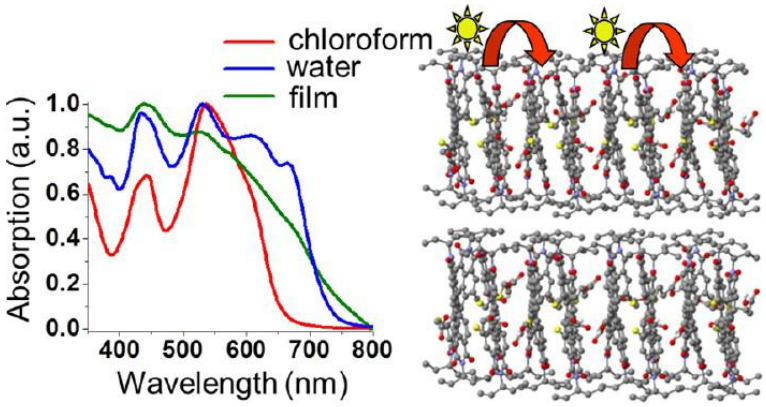
A methodology leading to facile self-assembly of crystalline aromatic arrays in dilute aqueous solutions would enable efficient fabrication and processing of organic photonic and electronic materials in water. In particular, soluble 2D crystalline nanosheets may mimic the properties of photoactive thin films and self-assembled monolayers, covering large areas with ordered nanometer-thick material. We designed such solution-phase arrays using hierarchical self assembly of amphiphilic perylene diimides in aqueous media. The assemblies were characterized by cryogenic transmission electron microscopy (cryo-TEM), revealing crystalline order and 2D morphology (confirmed by AFM studies). The order and morphology are preserved upon drying as evidenced by TEM and AFM. The 2D crystalline-like structures exhibit broadening and red-shifted absorption bands in UV-Vis spectra, typical for PDI crystals and liquid crystals. Photophysical studies including femtosecond transient absorption spectroscopy reveal that two of the assemblies are superior light-harvesters due to excellent solar spectrum coverage and fast exciton transfer, in one case showing exciton diffusion comparable to solid-state crystalline systems based on perylene tetracarboxylic dianhidride (PTCDA).



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