Multifunctional & sustainable 2D carbon nitrides for green hydrogen production and direct solar energy storage

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Many technologies are currently under development or already applied to tackle our increasing energy demand. Sunlight is the most sustainable energy source for such technologies, offering different ways of energy harvesting and transformation. To expand direct storage possibilities, we investigate organic photocatalytic materials that synthesize high value chemicals or chemical fuels and enable novel direct solar charging possibilities. For a fully sustainable energy infrastructure, also the material used should be environmental friendly, renewable, cost efficient and easy to synthesize. Carbon nitrides are a class of material fulfilling those requirements and are mostly studied as photocatalysts. Especially our recently discovered 2D carbon nitride poly(heptazine imide) (PHI) shows high photocatalytic efficiencies and has unprecedented light storing properties. PHI can mimic artificial photosynthesis by releasing stored solar energy in form of hydrogen hours after illumination ("dark photocatalysis") and even act as photo-anode for aqueous, direct solar batteries. To further improve and extend these applications, an in-depth understanding of structure–property–activity relationships is important. As such, after elucidating the molecular structure, targeted interfacial design by covalently bound surface functionalization of PHI is demonstrated. The functionalization boosts the bottleneck hole extraction and hence, photocatalytic hydrogen production from water, outperforming most of the known organic based photocatalysts. Based on these insights that affect the charge separation and interaction strength with small organic molecules, also other light-driven process can be tailored and optimized.

References:

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