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Introduction to photofunctional materials and transformations

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Photons are a combination of particles and waves, which carry both energy and information. Dedicated to the utilization and transduction of photons, photofunctional materials and transformations have profound meanings from fundamental understandings to applications.

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representative energy transformation, natural photosynthesis converts photon energy from the sun (solar irradiation) into chemical energy as the ultimate driving force for the biosphere. At the same time, the 'photofunctional materials' in our eyes process photon information to formulate our visual perception of the world. The beauty of photofunctional materials and transformations has aroused growing interest in physics, chemistry, mathematerial science, matics, biology, medical science, artificial intelligence, photonics and engineering. In this situation, the thematic collection on 'photofunctional materials transformations' offers a timely platform to witness and communicate emerging interdisciplinary discoveries.

This collection includes frontier articles, reviews and perspectives on solar-to-chemical conversions, organic photoredox transformations, photovoltaics, photoelectronics, photobiology and phototherapy. We endeavored to present the landscape of photofunctional materials and transformations in diverse and burgeoning branches, and among hundreds of interesting discoveries and insightful discussions in *Journal of Materials Chemistry A* (55), *Journal of Materials Chemistry C* (25) and *Chemical Communications* (50), a few examples are highlighted here.

Over the past few decades, the toolbox of photofunctional materials has greatly

expanded from organic π -molecules to metal complexes, nanomaterials and supramolecular assemblies, and smart collaboration of different materials therefore becomes critical to promote desired functions. In this collection, Shi (https://doi.org/10.1039/ host-guest D2TA09715J) reviewed assemblies to pre-organize and confine molecular catalysts and photosensitizers in close spatial proximity. These assemblies regulate photoinduced energy and electron transfer, mass transfer, reaction pathways and kinetics, and replicate the enzyme-like microenvironments natural photosynthesis to construct effective and selective solar-to-chemical devices.

The development of photofunctional materials boosts more effective solar energy utilization for sustainable energy supply. Particularly, ever-growing efficiency and cost-competitiveness of solar cells have been witnessed in the past few decades. In this collection, Hou *et al.* (https://doi.org/10.1039/D2TA07249A)

reported two low-cost pyrazine-based polymer donors with completely nonfused conjugated backbones, which attained a conspicuous 16.16% power conversion efficiency among organic solar cells based on low-cost polymer donors. In addition to molecular-level modifications, Shao, Pang and Cui *et al.* (https://doi.org/10.1039/D2TA09561K)

analyzed the current problems of

Cu₂ZnSn(S,Se)₄ (CZTSSe) solar cells, and highlighted interface engineering as an essential strategy to improve power conversion efficiencies.

Taking advantage of solar energy, photocatalytic conversion offers promising strategies for environmental remediation. Li and Wang et al. (https:// doi.org/10.1039/D2TA09523H) reviewed proceedings of photocatalytic (micro)plastics degradation from inorganic semiconductor oxides organic-inorganic hybrid composites, including doped and surface-modified nanoparticles. Pertinent directions on photocatalyst development, pretreatment of (micro)plastic reactants, and photocatalytic conditions are given to advance photocatalytic (micro)plastics degradation into an applicable technology in the future.

In addition to environmental protection, solar-to-chemical conversion offers innovative, carbon-neutral and atomeconomic alternatives to the energychemical manufacturing. intensive Here, Hou et al. (https://doi.org/10.1039/ D2TA09122D) fabricated a Z-scheme of photocatalyst assembly nonstoichiometric $W_{18}O_{49}$ onto twodimensional carbon nitride nanosheets. Benefitting from intense localized surface plasmon resonance absorption and a strong internal electric field enabled by appropriate band alignment, highly effective H₂O₂ photosynthesis was realized under broad-spectrum irradiation up to 700 nm, which offers an attractive alternative to conventional manufacturing under high temperatures and pressures.

To construct complex and value-added organic molecular skeletons, visible light photoredox catalysis brings unprecedented opportunities for photochemical transformations with high regio-, chemoand stereo-selectivity. Yang and Zuo et al. (https://doi.org/10.1039/D3CC00532A) dual bisphosphonium and cobaloxime catalysts to perform selective oxidation of benzylic alcohols under oxidant-free and environmentally benign conditions. The photochemical reaction showed exclusive reactivity at benzylic positions to selectively yield aldehyde products with promising scalability under continuous-flow conditions. Zhang and Yu et al. (https://doi.org/ 10.1039/D2CC06705F) achieved reductive cross-coupling of allylic acetates with tertiary/secondary alkyl bromides, by adopting dual photoredox/ palladium catalysis and Hantzsch ester reductant. The protocol facilitated $C(sp^3)$ - $C(sp^3)$ bond construction with an excellent stereoselectivity (up to 96% ee)

conversions, but also render new prospects for information display, storage and transduction. Che and Cheng et al. (https://doi.org/10.1039/D2TC05257A) three-color developed solutionprocessable white organic light-emitting diodes (SP-WOLEDs) comprising blue and orange luminescent Au(III) complexes and the deep-red tetraphenyldibenzoperiflanthene emitter. The WOLEDs demonstrated promising external quantum efficiency and a >90 color

and regio-selectivity (>95%) under mild

enable crucial energy and chemical

Photofunctional materials not only

conditions.

rendering index. Fang and Wu et al. (https://doi.org/10.1039/D2CC06707B) advantage tunable took of the photoswitching properties of photochromic dithienylethene-based polymers and realized effective pattern encoding with superb resolution up to about 30 nm. In https://doi.org/10.1039/ D2TC04430G, Ji and Gao et al. prepared hydrogels for effective green-to-blue upconversion, which featured excellent oxygen resistance, high transparency, strong mechanics, and malleability, maintaining promising efficiencies even after sealed storage for over 6 months. Li al. (https://doi.org/10.1039/ D2TA09607B) developed a molecular switch integrating AIE luminogens, and and NIR emissive photochromic components. Visible light irradiation under 405 nm quenched fluorescence of the molecular switch in the solid state, which was recovered under long wavelengths, exhibiting excellent fatigue resistance and cycling stability. Its PMMA film demonstrated prototypic 32-level optical information storage, showing photoswitchable NIR fluorescence molecules as potential photonic optical storage material.

We thank all authors, reviewers, and editorial and production staff of this themed issue. We hope you will enjoy this interdisciplinary feast of 'photofunctional materials and transformations' and it will spark new ideas in developing novel photofunctional materials and applying them to valuable transformations.