

Optoelectronics Meets Ionics: From Photo-Intercalation to Solar Batteries

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The transition towards a sustainable energy landscape depends critically on our ability to capture and store energy from intermittent renewable sources, particularly sunlight and wind. Achieving this goal calls for new materials and integrated device architectures that directly couple energy conversion with storage. Taking inspiration natural photosynthesis, we have recently identified a new class of light-storing materials in which solar energy is captured and retained through ion-mediated stabilization of photogenerated charge carriers.

In my talk I will reflect on the emerging field of optoionics¹ and explore its potential for the design of “optoionic” materials that integrate optoelectronic and ionic processes, exemplified by light storing 2D oxides, carbon nitrides and other molecular frameworks, including metal-organic frameworks (MOFs) and covalent organic frameworks (COFs).^{2,3} The coupling of solar energy conversion with electrochemical energy storage opens innovative pathways for next-generation energy systems, including “dark photocatalysis”, photomemristive sensors, direct solar batteries, and light-driven microswimmers with photocapacitive behavior.³⁻⁶ These concepts represent a new paradigm in self-powered, autonomous devices, where energy conversion, storage, and actuation are unified in a single material platform.

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