Nanoporous Functional Materials for Clean Energy and Environment

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In this talk, I will present a novel, stable, and ultraclean hybrid energy storage and conversion device that continuously supplies energy using naturally abundant resources such as sunlight, water, and CO_2. The device is primarily composed of nanoporous semiconductors, including carbon nitrides, phosphides, sulfides, and carbon-based materials. These materials are incorporated into stable, cost-effective photocatalytic semiconductor systems for converting CO_2 or seawater into clean fuels using solar energy. This breakthrough technology not only reduces CO_2 levels but also provides a sustainable source of clean energy.

I will discuss the development, capabilities, and current and future applications of multifunctional nanoporous materials, with a special focus on a new family of semiconducting nanostructures composed of carbon and nitrogen (carbon nitrides). These materials feature diverse pore diameters, nitrogen contents, and structures, making them essential components of the proposed clean energy and storage device.[1-11] Specifically, I will highlight the preparation of novel mesoporous C_3N_5, C_3N_6, C_3N_7, and C_3N_8 materials, along with their structural characterization using advanced spectroscopic techniques. Additionally, I will demonstrate how the chemical composition, structure, porosity, and functionalization of these unique materials can be precisely tuned. This includes the fabrication of carbon nitrides from single molecular precursors containing C, N, and S elements, as well as the synthesis of mono- and bimetallic sulfides.

In the second part of the talk, I will focus on the energy storage and photocatalytic performance of these nanoporous carbon nitrides and their hybrids, particularly in sunlight-assisted seawater water splitting and CO_2 capture and conversion. Emphasis will be placed on the bulk production of functionalized carbon nanostructures and their commercialization, including the demonstration of a pilot plant for CO_2 capture. Finally, I will present the integration of CO_2 capture and conversion technology with fuel cells, batteries, and supercapacitors to develop an advanced energy storage and conversion system capable of providing continuous energy for mobile and automotive applications. This innovative device is designed to not only produce clean energy but also continuously reduce CO_2 levels, offering a sustainable solution for global energy and environmental challenges.

References

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