Dual Pathways to Hydrogen: Microchannel Reforming and Photocatalysis on Macroporous Silicon Structured Supports

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Abstract

The transition toward a hydrogen-based economy demands the development of efficient, sustainable, and versatile production technologies. This presentation examines two innovative and complementary approaches that address this challenge from different yet converging perspectives, both using macroporous silicon-based monoliths. On one hand, we present a multifuel steam reformer based on a design incorporating one million microchannels, engineered to maximize thermal efficiency and operational flexibility. This system enables the conversion of various fuels—such as methane and ethanol—into hydrogen with conversion rates exceeding 90%, owing to enhanced heat and mass transfer and its potential for modular integration in distributed applications.

On the other hand, we explore an advanced photocatalytic system based on macroporous silicon coated with TiO_2 doped with noble metals (Au, Pt). This photoreactor leverages the porous silicon structure to increase active surface area and light harvesting efficiency, resulting in high hydrogen production rates under UV irradiation. The combination of the semiconductor support with metallic nanoparticles enhances charge separation and system stability.

Together, these studies illustrate complementary strategies for hydrogen production: one based on high-efficiency thermochemical processes, and the other on direct solar energy conversion. Their joint analysis reveals synergies and opportunities for designing hybrid systems that integrate efficiency, sustainability, and adaptability across multiple application scales.

References

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