**Reductive pathways in heterogeneous photocatalysis: advancing micropollutant degradation toward real-world applications**

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The persistence of micropollutants in aquatic environments represents a major challenge for water treatment technologies. While oxidative degradation has long dominated the field of advanced oxidation processes (AOPs), recent advances in heterogeneous photocatalysis have demonstrated that reductive pathways, driven by photo-induced electrons, offer a powerful, selective, and energy-efficient alternative for the breakdown of recalcitrant compounds such as pharmaceuticals and pesticides.

This keynote will explore the emerging field of photocatalytic reduction as a complementary or stand-alone strategy for micropollutant degradation. Emphasis will be placed on the design of photocatalysts that favor electron-rich surface reactions, including the engineering of defect sites, band structure modulation, and electron sink integration. We will present recent experimental work on metal-free and metal-doped semiconductors that exhibit superior reduction selectivity and stability under visible light irradiation. Additionally, the session will address the mechanistic insights into pollutant-catalyst interactions, including molecular modeling and the role of reactive intermediates, such as hydrated electrons.

By bridging fundamental materials chemistry with environmental engineering needs, this talk aims to highlight the potential of reductive photocatalysis to reshape how we think about pollutant detoxification in next-generation water treatment systems.

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