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Editorial

Environmental Catalysis in Advanced Oxidation Processes, 2nd Edition—Preface to the Special Issue

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This Editorial, "Environmental Catalysis in Advanced Oxidation Processes, 2nd Edition", highlights the expanding role of catalytic and photocatalytic oxidation technologies in addressing today's pressing environmental challenges. Bringing together advances in catalyst design and characterization, innovative reactor engineering, and mechanistic insights into oxidation pathways, this collection reflects the dynamic evolution of advanced oxidation processes (AOPs). Beyond showcasing technical progress, it underscores the importance of AOPs as key tools for achieving cleaner air and water through sustainable and energy-efficient approaches. Motivated by the global pursuit of green and resilient environmental technologies, this Editorial invites scientists, engineers, and students to explore new opportunities and inspire future breakthroughs in catalysis, environmental chemistry, and process engineering.

Featuring a collection of original research articles, this Special Issue begins with a study on the photocatalytic degradation of levofloxacin in aqueous media using metal-free graphitic carbon nitride (g-C_3N_4) under simulated solar irradiation (Contribution 1). The authors demonstrated the catalyst's high stability and identified the key roles of superoxide anion radicals ($^{\bullet}O_2{}^{-}$) and photogenerated holes (h^+) in the oxidative degradation pathway.

In Contribution 2, biochar derived from banana peel, promoted with copper phosphide (Cu_3P), was used to activate peroxydisulfate for the efficient removal of bisphenol S (BPS). The 2% Cu_3P/BPB/SPS system achieved 90% BPS degradation within 10 min, and both radical and non-radical pathways were shown to participate in the transformation, with the authors proposing a detailed degradation mechanism predicated on UHPLC/TOF-MS analysis.

The photo-Fenton degradation of sulfamethoxazole (SMX) was investigated to monitor changes in aromaticity and colour during treatment (Contribution 3). Kinetic modelling revealed that an optimal molar ratio of 1 mol SMX:10 mol H_2O_2 enabled a 71% elimination of aromatic intermediates, yielding colourless water with minimal turbidity and providing a predictive tool for efficient oxidant usage under environmentally friendly conditions.

Contribution 4 explored modified gasification slag as a low-cost catalyst for persulfate activation in the degradation of acetaminophen, highlighting the role of carbonyl and graphitic nitrogen functional groups as active sites. Non-radical oxidation pathways predominated, demonstrating the potential for industrial waste utilization in wastewater treatment.

Mo_2C was evaluated as a persulfate activator for the degradation of losartan in tertiary wastewater treatment in Contribution 5. The Mo_2C/SPS system achieved complete LOS removal and significant *E. coli* inactivation, particularly under simulated solar irradiation, showcasing synergistic effects between photocatalysis and advanced oxidation for both chemical and microbiological remediation.

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In Contribution 6, the influence of Au loading and TiO_2 support morphology on the catalytic wet air oxidation of glyphosate was reported. TiO_2+Au catalysts demonstrated enhanced degradation rates, with the Schottky barrier and surface adsorption of degradation products playing critical roles in catalyst activity and longevity.

Catalytic wet air oxidation was further applied for the disposal of excess activated sludge from a coal chemical wastewater treatment process using Cu-Ce/γ-Al_2O_3 catalysts (Contribution 7). High removal rates of volatile suspended solids (93.2%) and chemical oxygen demand (78.3%) were achieved, and the process generated volatile fatty acids that could serve as carbon sources for subsequent biological treatment.

Innovative reactor designs were highlighted in two studies. First, a rotating photodisc reactor (RPR) using ZnO doped with aluminum nanoparticles demonstrated 50–62% pyridine degradation under natural light, emphasizing the importance of catalyst doping and reactor design for enhanced photodegradation (Contribution 8). Second, in Contribution 9, a 3D-printed modular photoelectrochemical (PEC) reactor was developed to couple seawater splitting with solid-state hydrogen storage, showing excellent performance and stability over 300 h across a broad pH range.

This Editorial also features two comprehensive reviews. Contribution 10 provides an in-depth overview of the synthesis and photocatalytic performance of distinct nanooxides, including Ti, Zn, Cu, Fe, Ag, Sn, and W oxides, illustrating strategies to enhance photocatalytic efficiency through heterostructure formation and material modification. The second review summarizes recent advances in the removal of organic drugs using AOPs, highlighting methods such as UV, ozone, Fenton-based processes, and heterogeneous photocatalysis while discussing their advantages, limitations, and mechanistic insights (Contribution 11).

Taken together, the contributions in this Special Issue provide mechanistic insights, practical knowledge, and technological innovations that advance the field of environmental catalysis and AOPs. They demonstrate how material design, process intensification, and reactor engineering can improve the efficiency of pollutant removal. This Editorial is intended as an up-to-date resource for researchers, engineers, and students, offering a comprehensive perspective on state-of-the-art strategies to address global environmental challenges and promote sustainable approaches for cleaner water and air.

We extend our heartfelt gratitude to all the authors for their invaluable contributions, without which this Special Issue would not have been possible. We hope that the original research papers and review articles included will help advance the understanding and resolution of current challenges in the field. Our sincere thanks also go to MDPI's *Catalysts* journal for granting us the opportunity to serve as Guest Editors and contribute to the ongoing development of environmental catalysis for water remediation. We are particularly grateful to the Assistant Editor, Ms. Patty Ge, for her dedicated efforts and collaboration throughout the publication process. Finally, we express our appreciation to all the reviewers for their essential and thoughtful evaluations, which greatly enriched this Special Issue.

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