Multi-metal Oxide Catalyst for Electrochemical Oxidation of Organic Pollutants

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Electrochemical advanced oxidation processes (EAOPs) have emerged as promising wastewater treatment methods, utilizing electrochemically generated strong oxidants like hydroxyl radicals (•OH) to degrade organic pollutants. The electrochemical activity and rate of hydroxyl radical generation on the anode surface is crucial for EAOP efficiency. This research plan aims to develop efficient, low-cost, and long-lasting anodes for the electro-oxidation of organic pollutants in wastewater. The study focuses on two key components of the anodes: electroactive materials and conductive substrates. Active electrode materials will include metal oxides with oxygen vacancies, such as spinels, Perovskites, layered double hydroxides (LDHs), and high entropy oxides.[1,2] The incorporation of oxygen vacancies enhances catalytic activity. 3D porous conductive substrates, commonly used in redox flow batteries and water electrolyzers, will be employed to increase electrode-electrolyte contact and facilitate a flow-through design.

The research objectives encompass studying active electrode materials, synthesizing and characterizing 3D porous substrates, evaluating the physicochemical structure and electrochemical properties of the electrodes, designing and optimizing an electrochemical cell, analyzing electrode performance through electro-oxidation experiments, and exploring the potential of coupling electro-oxidation with other electrochemical processes.

The methodology involves synthesizing and characterizing active electrode materials, fabricating working electrodes, optimizing synthesis processes, characterizing 3D porous substrates, studying their effect on oxidation efficiency, evaluating physicochemical and electrochemical properties, designing and optimizing electrochemical cells, testing electrode performance under different conditions, and assessing the potential of hybrid electrochemical cells.

The expected impacts of this research include advancements in electrochemical advanced oxidation processes for wastewater treatment, novel insights into anodic oxidation, potential applications for organic pollutant removal. Dissemination of findings through publications, conferences, and collaborations with industry partners and policymakers aims to ensure practical applications and meaningful societal impact, enhancing ecosystem resilience and drinking water quality against organic pollutants.

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References:

(1) Kim, J. S.; Kim, B.; Kim, H.; Kang, K. Recent Progress on Multimetal Oxide Catalysts for the Oxygen Evolution Reaction. *Adv. Energy Mater.* **2018**, *8* (11), 1702774. https://doi.org/10.1002/aenm.201702774.

(2) Kumar, A.; Kumar, A.; Krishnan, V. Perovskite Oxide Based Materials for Energy and Environment-Oriented Photocatalysis. *ACS Catal.* **2020**, *10* (17), 10253–10315. https://doi.org/10.1021/acscatal.0c02947.