Research project and supervisory team

Supervisory Team	Dr. Yong Ren; Prof. Jun He; Prof. Yuying Yan
Short introduction & description of research project	Converting carbon dioxide (CO_2) into chemical fuels through photocatalytic process via harvesting solar energy has attracted increasing attention as a promising technology to reduce carbon emission and mitigate the greenhouse gas effect. The state-of-art photocatalytic materials mainly rely on ultraviolet light irridation, and the photocatalytic applications are hindered by a number of bottlenecks such as low solar energy utilization rate, poor selectivity of reduced product, limited photogenerated electron-hole separation efficiency, and unsatisfactory CO2 conversion efficiency. Therefore, it is important to study the mechanisms and methods to enhance the visible-light induced photocatalytic reduction efficiency of carbon dioxide. In this study, microfluidics will be applied to fabricate porous microfiber membranes, the surface of which will be integrated with one-dimensional metal oxide nanorod arrays to form branched nanorod hierarchical heterostructures, which can increase the mobility of charge carriers to the surface of the fiber membrane and improve the photocatalytic activity. The mechanism of the effective separation of photogenerated charges by the 1D branched nanorod hierarchical heterostructure will be elucidated, and the migration principles of the photogenerated charges on the surface of the materials with nanopores and nanorods will be studied. The heat and mass transfer model combing CO2 adsorption/diffusion with photocatalytic reaction will be established. The transport mechanism of CO2 molecules and water vapor molecules in porous media as well as their mutual-working mechanism will be studied. The contribution of heat transfer to the mobility of the photogenerated charges will be investigated. The role of the coupling mechanism between heat and mass transfer with regards to the carbon capture process and visible light induced photocatalytic reduction process will be elucidated. The heat and mass transfer mechanism of gas-liquid trans-membranes will be studied as well. The research will pave a way for development of the microfiber membrane technology which can lead to efficient capture and photocatalytic reduction of CO2 under visible light into methane. Ultimately, the research project will provide new insights to understanding the light-heat coupling mechanism, and absorption-diffusion coupling mechanism in photocatalytic process, and it will inspire novel energy-saving and environmental-protection applications.
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