

Photo- and Electrocatalysis for Sustainable Environment

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Abstract: The global environment is challenged by excessive consumption of fossil fuels and resources, which perturbs the nature's sustainable cycles of various chemical elements such as C, N, O, and H. As solar energy is the major driving force of the global cycles of these key elements, photo(electro)catalysis is an ideal engineering method to mimic and restore the nature's element cycles. The photochemical conversion of H_2O , CO_2 , N_2 , and O_2 has been intensively investigated employing various methods among which photo(electro)catalysis using semiconductor materials has been established as the most popular method. This talk will introduce several examples of photocatalytic, photoelectrochemical (PEC), and electrocatalytic conversions of C, N, and O compounds and discuss their environmental implications. The photocatalytic and photoelectrocatalytic processes have been applied to denitrification, de- NO_x , and nitrogen fixation reactions but the successful performance is limited. The direct conversion of nitrogenous pollutants to dinitrogen and dinitrogen to ammonia without using chemical reductants is an ideal solution but difficult to be realized. Here we introduce various engineered photo(electro)catalytic systems that selectively interconvert among NO_3^- , NO_2^- , NO , NH_4^+ , and N_2 . As for O conversion, some examples of photocatalytic and photoelectrochemical systems for sustainable production of H_2O_2 through O_2 reduction will be introduced. A PEC system enabled continuous H_2O_2 production over 100 h even under a bias-free condition. As for CO_2 conversion, a unique example that controls the selectivity of the multi-electron transfer mechanisms of CO_2 transformation using heteronuclear dual-atom-site catalyst to generate an uncommon product (HCHO) will be also discussed.

Bio: Wonyong Choi is a Distinguished Professor and Director at the Institute of Environmental & Climate Technology at the Korea Institute of Technology in Naju, Korea. He received his PhD in Chemistry from the California Institute of Technology and MS and BS degrees from Pohang University of Science and Technology and Seoul National University, respectively. His research focuses on semiconductor photocatalysis for environmental and energy applications, solar fuel production, advanced oxidation processes (AOPs), physicochemical methods for the destruction of recalcitrant pollutants, and environmental photochemistry and ice chemistry.

Choi is an elected International Member of the US National Academy of Engineering and an elected Member of the National Academy of Engineering of Korea. He received the 2024 Korea Toray Science and Technology Prize and is the Editor-in-Chief of ASC ES&T Engineering, and an editorial board member of various other science and technology journals.

