Progress on Clean Hydrogen Production Based on Chemical Looping and Its Efficient Storage Employing Triply Periodic Minimal Surface Structure

Professor Muhammad Aziz
Institute of Industrial Science, The University of Tokyo
Email: maziz@iis.u-tokyo.ac.jp

Abstract

Hydrogen has been considered as a promising clean secondary energy source in the future, accompanying electricity. The production of hydrogen can be conducted via several routes, including thermochemical, electrochemical, and biological processes. Among thermochemical conversion technologies, chemical looping has a high potential to be adopted in the future due to its high energy efficiency and the capability to separate CO2 simultaneously during the conversion. First, chemical looping with three circulated reactors is adopted for clean hydrogen production. The system consists of a fuel reactor, a steam reactor, and an air reactor. Oxygen carriers are circulated among those reactors to facilitate the reaction, especially in terms of reduction and oxidation. However, to establish this technology, several challenges must be clarified and solved, especially some issues correlated to the performance of oxygen carriers, reaction mechanisms, reactor and particle fluidization, controllability, and process integration. Several of our works on those issues are described in order to improve the feasibility of three-reactor chemical looping technology. Second, triply periodic minimal surface is further developed and adopted for absorption-based efficient hydrogen storage. The structure has significant advantages as hydrogen storage due to its high strength, excellent heat exchange, high structural freedom, and excellent topological optimization. Some structures and their topological optimization have been explored in order to obtain the most efficient hydrogen storage in terms of hydrogen storage density, charging and discharging rates, and mechanical strength.