

Carbon Neutral/Negative Conversion of Carbon Resources Into Power and Chemicals

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Keynote Speakers

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Short Biography

Jun-ichiro Hayashi has been a professor of Institute for Materials Chemistry and Engineering, Kyushu University, since 2009, and also the director of this institute since 2017. He received his doctoral degree of Engineering from Kyushu University in 1996. He was an associate professor (1996–2005), and then professor (2005–2009) of Hokkaido University. His major academic field is chemical engineering and chemical reaction engineering. His research area ranges over upgrading and conversion of carbon resources (hydrothermal, oxidation, pyrolysis, gasification and carbonization), carbon/inorganic materials, and environmental technologies. His recent and particular interest is in carbon-neutral/negative coproduction from fossil fuels and biomass and sequential production of a variety of chemicals/materials from woody and herbaceous biomass in aqueous systems.

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Abstract

Our societies are requested to reduce artificial CO₂ emission by 80% by 2050 and 2070 and realize zero emission. Future implementation of technologies for fossils-derived CO₂ capture and storage (CCS) is expected, but there are many environmental, geological and geopolitical uncertainties/risks in CCS. Chemical utilization of CO₂ as a chemical feedstock (CCU), which normally needs H₂ from solar or wind power, may be a way to 'store' CO₂. But, direct use of such renewable power is, in fact, more effective for reducing CO₂ emission than its transformation into H₂ for CCU. The authors believe that carbon resources (fossils and biomass) can be converted simultaneously into power and organic compounds that are safely stored and also available as chemicals, and here propose a system that is free from combustion. In the proposed system, a carbon resource is converted into syngas with steam and/or CO₂ and high-temperature heat from solid-oxide fuel cells (SOFCs as power generators). The syngas is sent to a water-gas shift and gas separation (with membrane) processes, which supply pure H₂ into the SOFCs while a H₂/CO or H₂/CO₂ mixture to reactors to produce chemicals (olefins, aromatics, alcohols, acids, esters, etc.). Our process simulations reveal, for example, that the proposed system can convert lignite into power with an efficiency of 50%-LHV and a particular type of organic material, oxalic acid (C₂H₂O₄) with yield as high as 120–140%. In other words, this system has a potential of realizing carbon-negative coproduction of power and organic matter that can safely be stored as well as used. Oxalic acid is a very interesting organic matter. It is available to synthesis of esters and polymers, and moreover, to reduction of iron oxide to metallic iron with solar light and heat at temperature below 500°C. More details will be presented in the symposium.