<Research Topics>

Microscopic Exploration of Novel Electrocatalytic Fields Using Single-Crystal Model Electrodes

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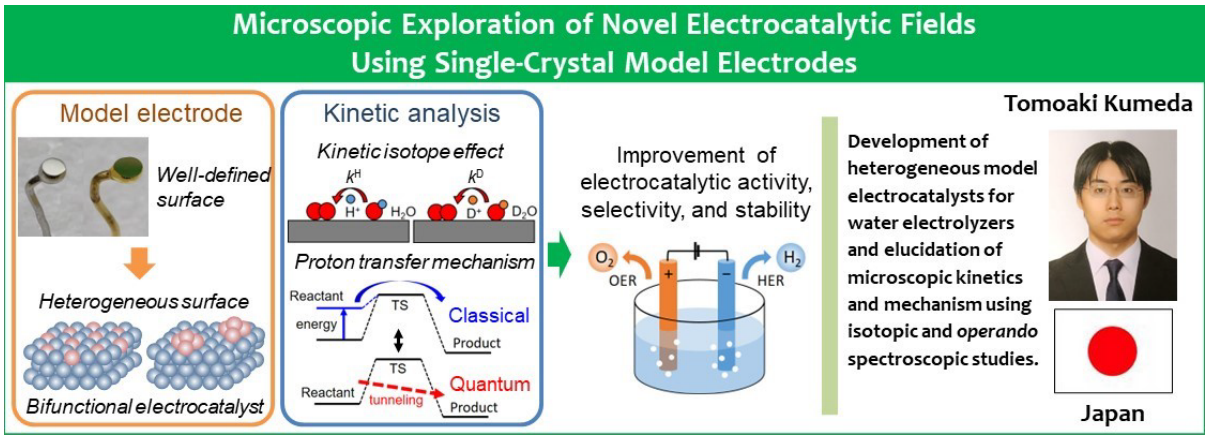

■Research

My research is focused on understanding the kinetics and mechanism of electrochemical reactions using single-crystal electrodes and finding functional nanoscale structures in electrocatalysis. Electrochemical energy conversions, such as fuel cells and fuel production, are essential for sustainable development. However, these electrochemical systems usually require precious metal electrocatalysts, preventing widespread use. Furthermore, electrode processes, including electron and ion transfers, are still unclear even for a simple reaction like the hydrogen evolution reaction ($2H^+ + 2e^- \rightarrow H_2$). The profundity of electrochemical reactions is due to the sensitivity toward the surface structure of the electrode and complicated interactions with electrolyte ions and water molecules. Therefore, fundamental studies have been employed on well-defined single-crystal model surfaces, which can provide insights into the reaction mechanism based on the nanoscale structure and the effective utilization of precious electrocatalytic materials.

My Ph.D. studies revealed that hydrophobic ions modify the hydrogen-bonded water structure at the electrode−electrolyte interface and improve the fuel cell reaction activity. Recently, our research group at NIMS has been studying the effect of nanoscale structure and electrolyte ions on interesting electrode processes, such as outer-sphere proton-coupled electron transfer and quantum proton tunneling. At ICYS, I plan to expand our research into multifunctional heterogeneous model surfaces and solid electrolytes.

■Comments

I am so delighted to be a member of ICYS. After receiving my Ph.D. degree at Chiba University, Japan, I was employed as a postdoctoral researcher at NIMS in April 2020. From April 2021, I continued my research at NIMS with support from JSPS postdoctoral fellowship for two years. At ICYS, I will make an effort to conduct creative and high-quality work and contribute to the society with research products. Also, I look forward to discussing studies with ICYS members and researchers in various fields.

■Link

https://www.nims.go.jp/icys/research/#KUMEDA