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Top -level research and data

Creation of new devices and systems using nanoelectrochemistry
(Representative papers)
Zn dissolution–passivation behavior with ZnO formation via in-situ characterizations, Homma, T. et al., *Energy & Environmental Materials*, 2022, e12481　DOI: 10.1002/eem2.12481

Keyword

- Nanostructure formation process
- Surface / interfacial reaction analysis
- Surface-enhanced Raman spectroscopy
- Energy devices
- Memory / recording devices
- MEMS
- Functional surface chemistry

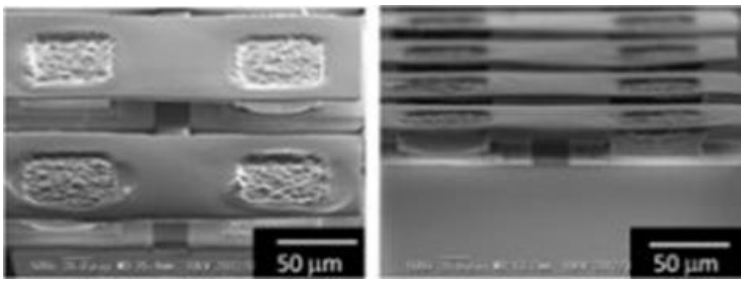
Deployment targets (sites, materials, etc.)

Energy devices, Post Li ion batteries, hydrogen systems, and solar cells

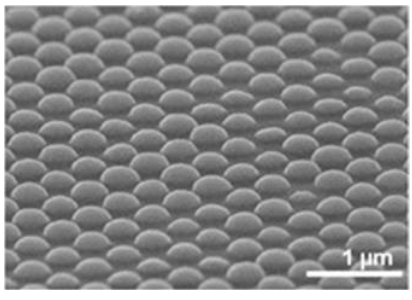
Features (implementation means, etc.)

Working to create new materials and devices and design reaction processes through nanoscale analysis focusing on solid–liquid interfaces (electrode interfaces) and surfaces. Research is mainly conducted on the following areas: “nano / micro scale fabrication,” in which new materials and devices are created based on nano / micro-processing technologies and electrochemical reactions; “energy devices,” which involves process development and device fabrication for innovative zinc secondary batteries, anion exchange membrane water electrolysis, thermoelectric conversion elements, solar cell grade silicon production, etc.; and “interfacial reaction mechanism analysis,” which involves experimental and theoretical analysis of reaction mechanisms at interfaces. Specifically, the following five research areas are being promoted:

1. **Advanced nanostructure / device processes:** development of fabrication processes that combines nano / micro scale processing technology (e.g., lithography) with electrochemical reactions (electrolytic / electroless deposition), and creation of new nano-functional materials and devices. Examples) Thermoelectric conversion devices, ferromagnetic nanodot array for bit patterned media, and 3D magnetic memory devices.
2. **Nanoscale analysis for interfaces using plasmonic sensor devices:** Development of plasmonic sensors for surface-enhanced Raman scattering and application to nanoscale analysis of electrode reactions and surface / interfacial nano structures. Examples) Analysis of electrode reactions in lithium-ion and zinc secondary batteries, elucidation of electrolyte decomposition and surface film formation processes that greatly affect battery characteristics, and dynamic analysis of micro / nanoscale tribological interfaces
3. **Electrode surface process analysis:** Analysis and design of new electrodes and reaction processes, focusing on electrode reactions of innovative zinc secondary batteries, which are attracting attention as large-scale energy storage and conversion technologies, and hydrogen generation reactions using electrode catalysts.
4. **Silicon purification processes / device process:** Aims to establish a process for removing light elements such as boron that affect semiconductor properties by designing a flow path device using a 3D printer and controlling fluid behavior to conduct solvent extraction
5. **Solid–liquid interface reaction mechanism analysis:** Electrode reactions proceed in a unique reaction field called the solid–liquid interface, so analyzing and understanding interfacial phenomena at the atomic and molecular levels are essential. Meanwhile, many aspects of the reaction mechanism in solid–liquid interface reactions cannot be fully clarified through experiments alone, and theoretical analyses by employing various computational chemistry methods are also being conducted.



Π-shaped micro thermoelectric devices



Si nanostructures fabricated using electrochemical process

Associated proprietary technologies

- A zinc-based next-generation energy conversion and storage system
- Dynamic observation / analysis of nanoscale surfaces and interfaces using surface-enhanced Raman microscopy for ultra-sensitive surfaces and interface analysis using plasmon sensors
- Atomic and molecular-level analyses of reaction processes by employing computational chemistry methods
- Functional micro / nanostructure formation and property control by wet processes

Expected outcome/ applications

Creation of new functional materials and devices, such as innovative storage battery systems that will come after lithium, and establishment of precise design and process control guidelines at the atomic and molecular levels

Associated SDGs