SHIKAZONO LAB.

[Solid Oxide Fuel Cell and Next Generation Heat Engines]

Integrated Research Center for Sustainable Energy and Materials

Thermal Energy Engineering

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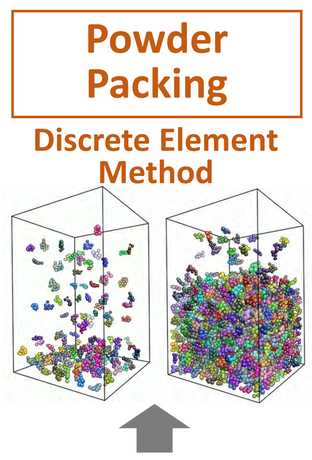
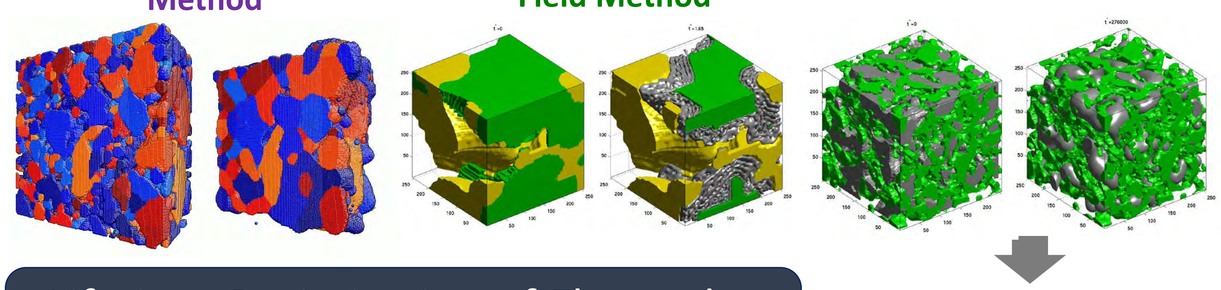
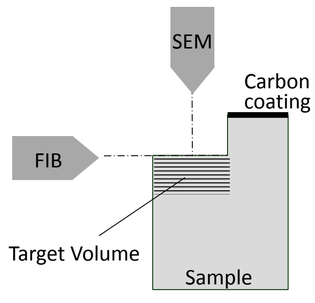
Polarization Characteristics and Microstructures of Solid Oxide Fuel Cell Electrodes

It is known that electrode microstructures strongly affect polarization characteristics of solid oxide fuel cells (SOFCs). Large scale numerical simulation tools such as lattice Boltzmann, phase field, kinetic Monte Carlo and discrete element methods are developed to optimize whole lifetime characteristics of the electrodes from initial powder to long time operation. Three dimensional microstructures reconstructed by FIB-SEM plays inevitable role for model validation.

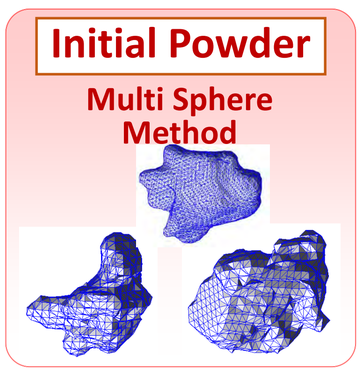




Hitachi NX9000

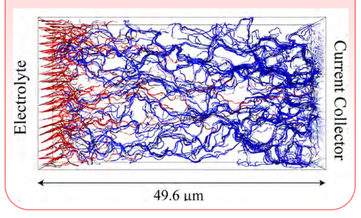


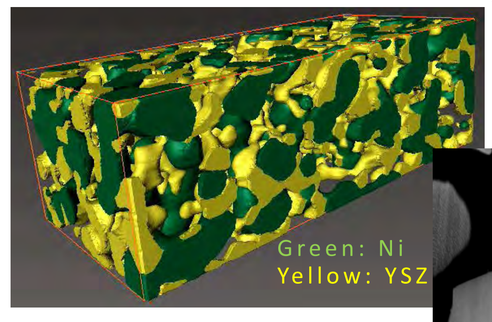
Orthogonally-arranged FIB-SEM

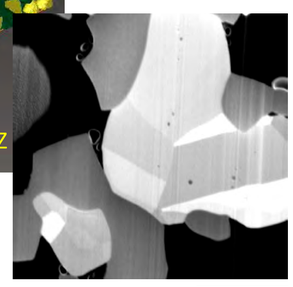


Lifetime Optimization of Electrodes
From initial powder to long time operation

- Microstructure optimization considering fabrication and operation processes
- Prediction of final electrode overpotential from initial powder information as input parameters
- Design based on non-empirical approach
- Quantitative validation using FIB-SEM







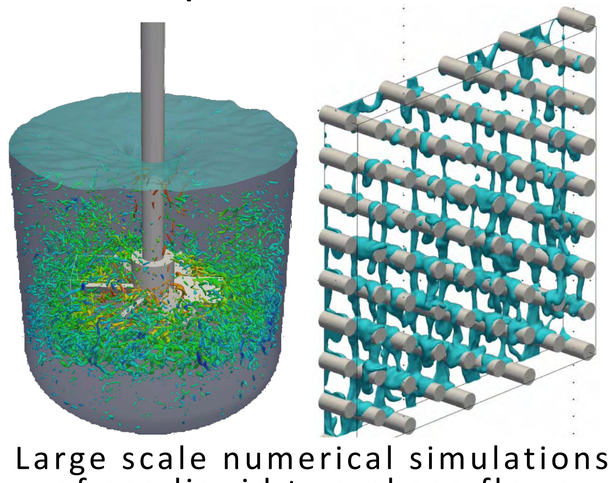
Quantitative characterization of electrode microstructures using focused ion beam scanning electron microscope (FIB-SEM)

Next Generation Heat Engines

Efficient utilization of thermal energy will become even more important in the future. In order to reduce exergy loss from the heat processes, heat engines which operate at small temperature differences, and component technologies such as compact gas-liquid separators and compact heat exchangers are developed under collaboration with industry partners.

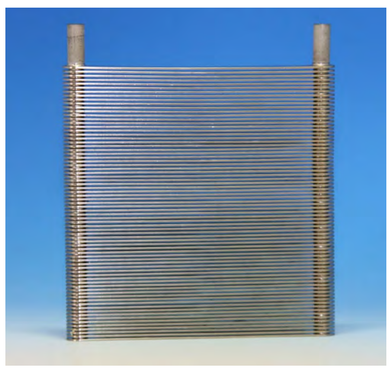
- Development of trilateral cycle and oscillating steam cycle heat engines
- Large scale numerical simulation of two phase flows using super computers
- Development of component technologies: laminar heat transfer enhancement, compact gas-liquid separators, compact finless heat exchanger, etc.

Two phase expander & demonstration unit for trilateral cycle



Large scale numerical simulations of gas-liquid two phase flows

Compact gas-liquid separator



Compact finless heat exchangers