

SHIKAZONO LAB.

[Solid Oxide Fuel Cell (SOFC) and Next Generation Heat Engines]

Collaborative Research Center for Energy Engineering

<http://www.feslab.iis.u-tokyo.ac.jp/>

Thermal Energy Engineering

Polarization Characteristics and Microstructures of SOFC Electrodes

In solid oxide fuel cell (SOFC) electrodes, three (or two) phase boundary and tortuosity strongly affect the polarization characteristics. Three dimensional electrode microstructure is quantified by FIB-SEM, and numerically simulated by lattice Boltzmann and phase field methods.

- ◆ **Dual Beam FIB-SEM** : Reconstruction of microstructures with resolution up to several nm
- ◆ **Lattice Boltzmann method** : Coupled simulation of diffusion and electrochemical reaction
- ◆ **Phase field simulation** : Numerical prediction of degradation by Nickel sintering
- ◆ **Phase field simulation** : Numerical prediction of fabrication process

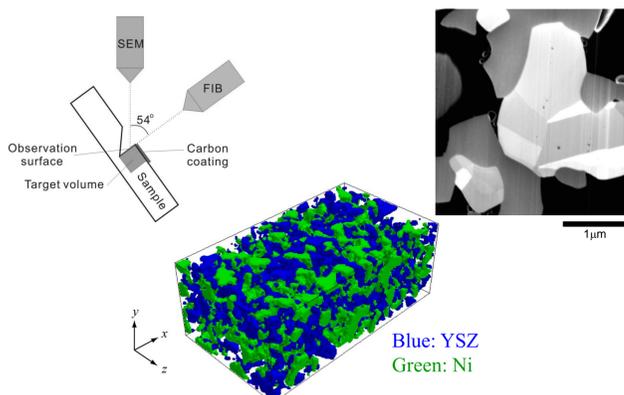


Fig. 1 Dual Beam Focused Ion Beam-Scanning Electron Microscope

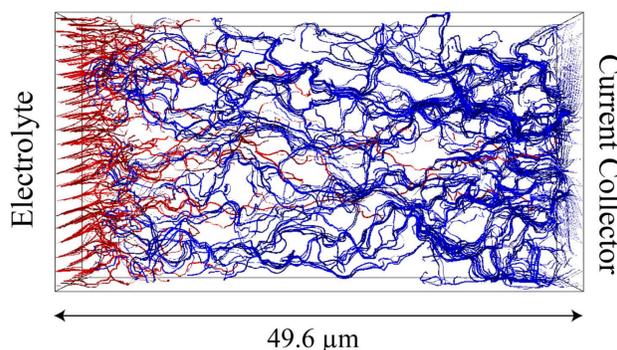


Fig. 2 Ionic (red) and electronic (blue) currents inside polarized anode

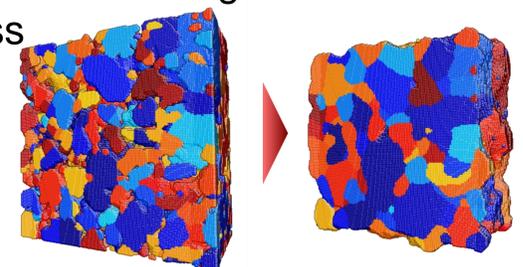


Fig. 3 Sintering of NiO-YSZ powders during fabrication

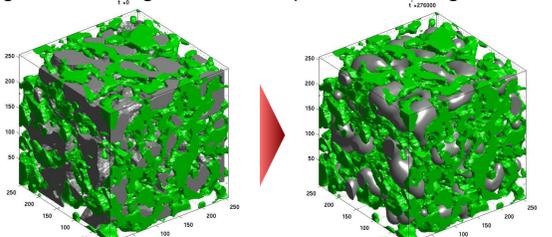


Fig. 4 Phase field simulation of Ni (gray) sintering in Ni-YSZ anode

R & D of Next Generation Heat Engines

Novel steam cycles, numerical simulation of two phase flows, component technologies such as finless heat exchanger, gas-liquid separator and oblique wavy surface are proposed and developed under collaboration with industry partners.

- ◆ **Novel steam cycles**: Trilateral and Oscillating steam engines
- ◆ **Numerical simulation of two phase flows**: Fluid flows, interface motion, heat transfer, etc.
- ◆ **Development of component technologies**: Heat transfer enhancement in laminar flow, Compact gas-liquid separator, Compact finless heat exchanger



Fig. 5 Expander & demonstration unit for Trilateral steam cycle

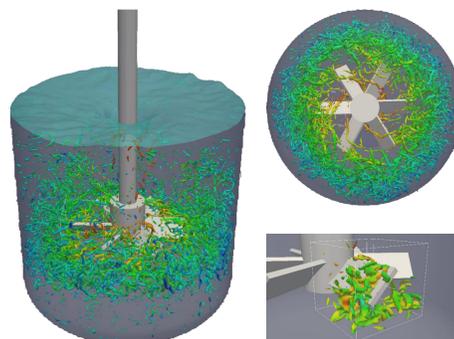


Fig. 6 Visualization of two phase flow structure and gas-liquid interface shape inside a mixing tank



Fig. 7 Compact gas-liquid separator



Fig. 8 Compact finless heat exchanger