# SHIKAZONO LAB.

## Efficient Energy Conversion

Department of Mechanical and Biofunctional Systems
Research Center for Sustainable Material Energy Integration, Energy System Integration Social Cooperation Program

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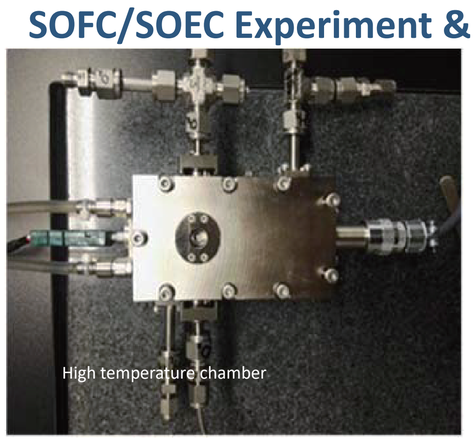
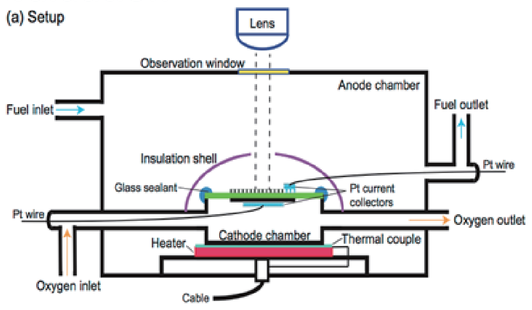
http://www.feslab.iis.u-tokyo.ac.jp/index-e.html

## Evaluation of Electrode Performance and Reliability of Solid Oxide Fuel Cell/Electrolysis Cell Electrodes

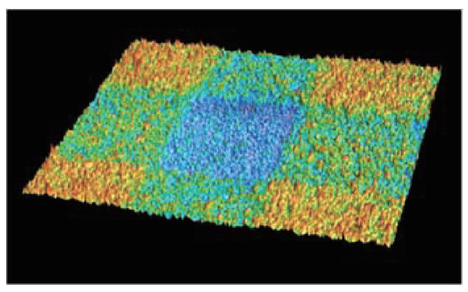
Electrode microstructures strongly affects the performance and reliability of solid oxide fuel cells (SOFCs) and electrolysis cells (SOECs). Numerical simulation tools such as lattice Boltzmann, phase field, kinetic Monte Carlo and discrete element methods as well as machine learning tools, e.g. CNN, CGAN, UNIT, LSTM, PINN, etc. are developed to investigate the electrode characteristics from initial powder to long time operation. Three dimensional microstructures reconstruction by FIB-SEM and operando observations play inevitable role for understanding the phenomena and model validation.

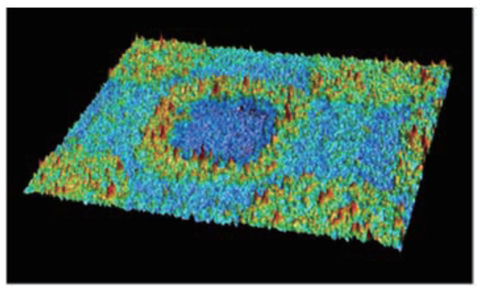
### SOFC/SOEC Experiment & Evaluation



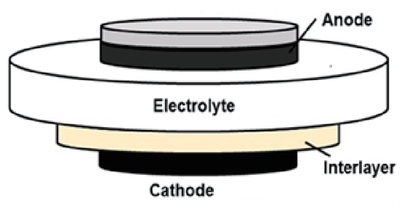

850°C, $V_{A\text{-}C}$=0.5 V
$H_2$:$N_2$:$H_2O$ = 10:87:3 %, $O_2$ = 100%

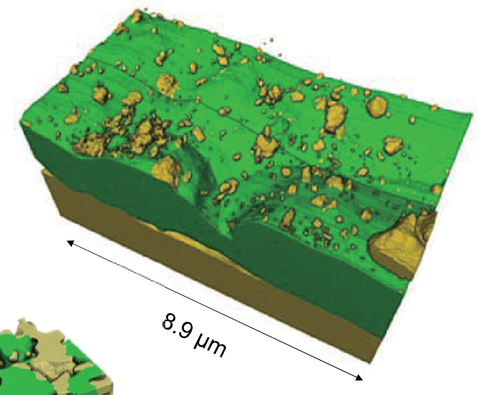


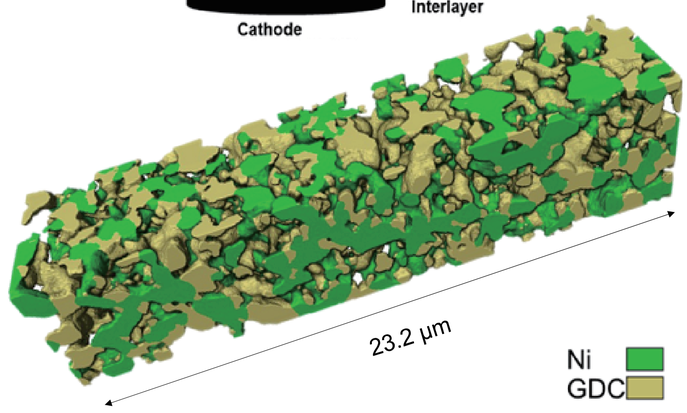


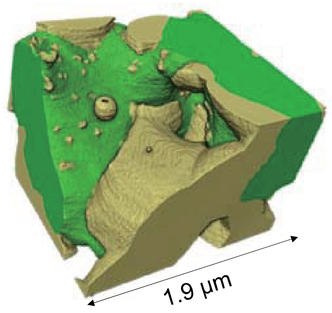
Operando observations of patterned Ni-GDC electrodes under real high temperature operation at 800°C.

### Electrode microstructure multiscale characterization



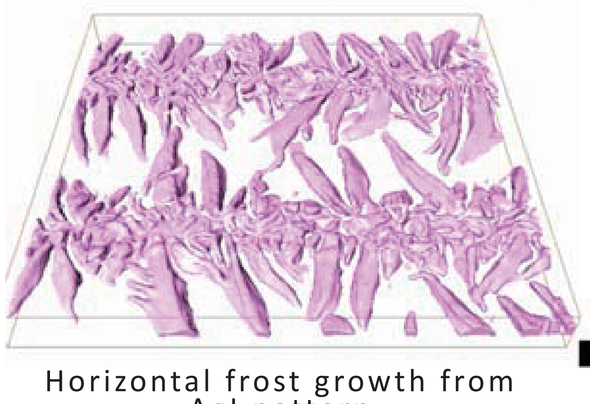



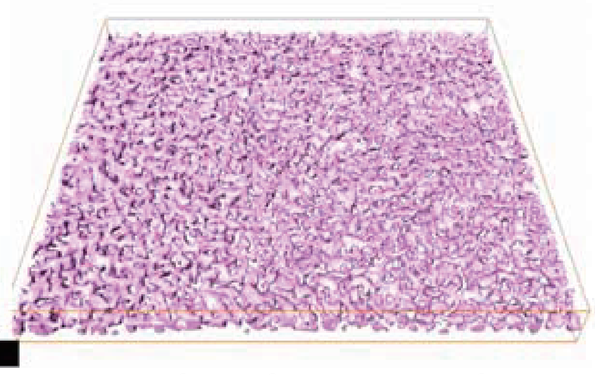

Quantitative characterization of electrode microstructures using high resolution (2nm) focused ion beam scanning electron microscope (FIB-SEM)

## Next Generation Heat Pumps & Heat Engines

Efficient utilization of thermal energy is becoming even more important to reduce final energy consumption. In order to reduce exergy losses, thermal cycles which operate at small temperature difference, and component technologies such as efficient heat exchangers and gas-liquid separators are developed under collaborations with industry partners.

- Novel steam/refrigerant cycles (2 phase expansion/compression, Lorenz cycle)
- 3D measurement of frost microstructure
- Heat exchangers and gas-liquid separators, etc.



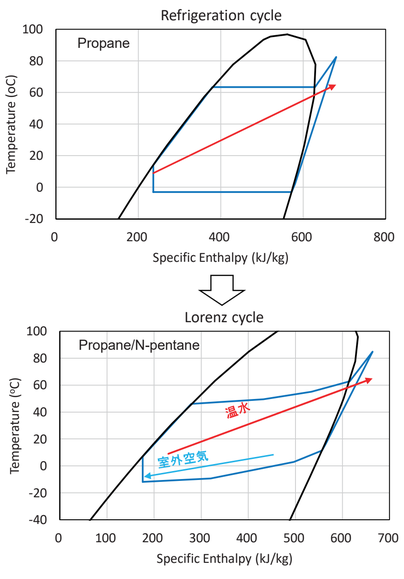



Horizontal frost growth from AgI pattern

Dense frost from PET surface

Reconstruction of frost 3D microstructures by replica method

High performance anti-scale V-fins




Large temperature glide Lorenz cycle heat pump