

# Basic Science for Solid Oxide Fuel Cells

Dr Stephen Skinner

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# SOFC group at Imperial

Alan Atkinson

Durability, mechanical properties

Nigel Brandon

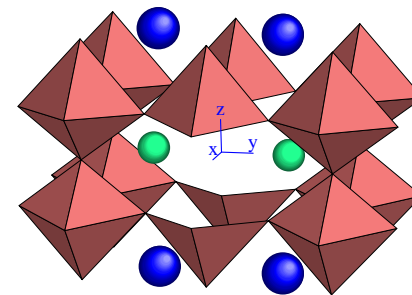
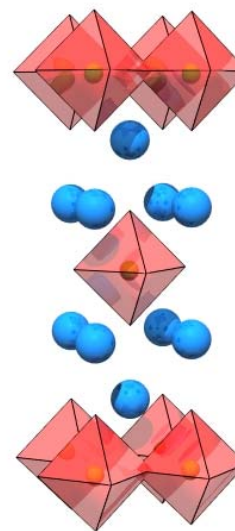
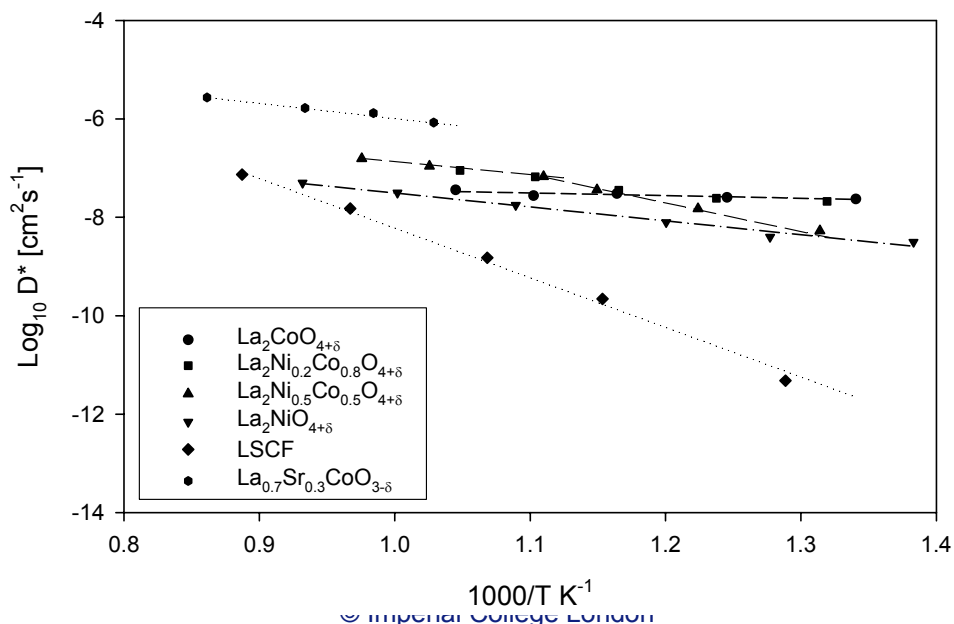
Scale-up, device testing, fuelling

John Kilner

Kinetics, cathodes, new materials

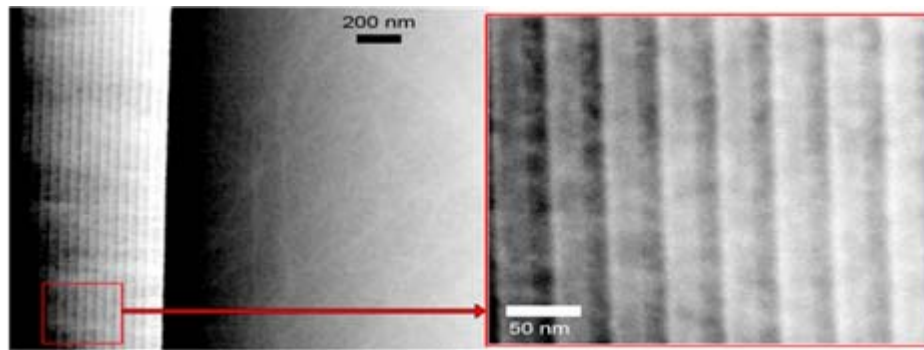
Stephen Skinner  
(JTI Rep.)

*In-situ* measurement, electrolytes, cathodes, new materials

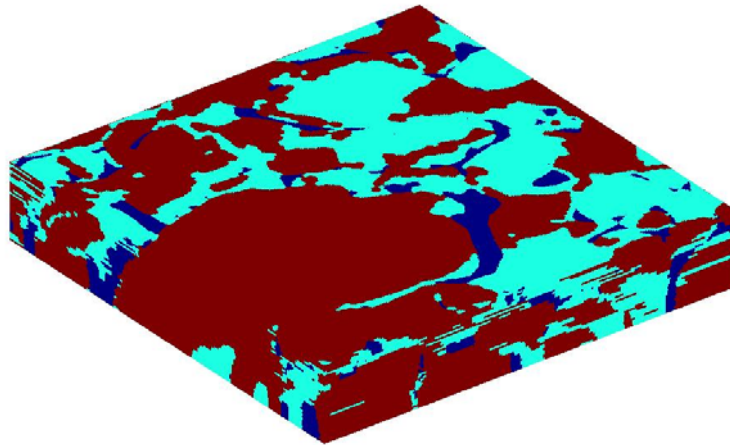


# Basic science requirements: Challenges and capabilities

- Understanding of mechanical aspects of SOFCs – important but somewhat neglected.
- Related to durability – key industry requirement.
- Nanostructured oxides – conductivity enhancements?
- Modelling of electrodes – FIB techniques.
- Materials simulation – conduction pathways, materials discovery.
- Kinetic measurements – isotopic labelling, diffusion.
- Leakage – constrained sintering development.
- *In-situ* characterisation of operating cells – diffraction, neutron, Raman, optical techniques.

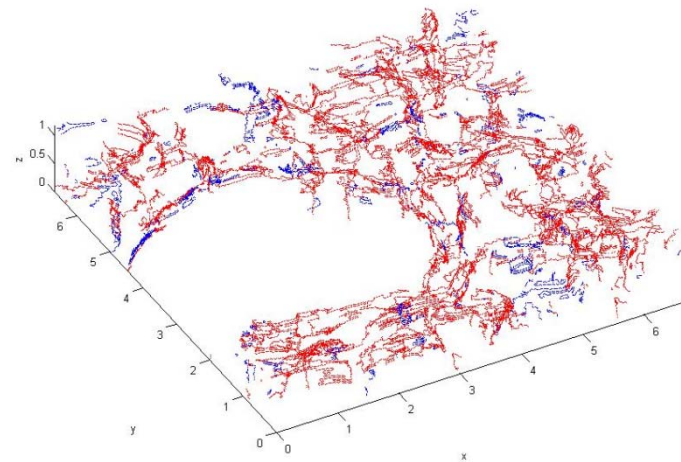


TEM imaging of superlattice structure highlighting contrast differences



3D Imaging of a high density Ni-YSZ Anode (Dimensions 6.8 x 6.8 x 1.2 $\mu\text{m}$ ) Red refers to Ni, green to YSZ and blue to pore space.

## Example of Electrode Modelling & Nanomaterials Characterisation



TPB Map for Ni-YSZ Anode shown opposite, lines represent three phase boundaries. Red lines show the percolating TPBs, blue lines show the non-percolating TPBs. The scale is given in  $\mu\text{m}$ .

# Responding to technical challenges presented by Industrial partners

- Processing and durability
- High performance materials (cathodes, anodes, interconnects)
- Improved performance at low temp.
- Understanding failure mechanisms