Core-Shell Heterostructures for Solid Oxide Fuel Cells

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Team Organization

PI: Srikanth Gopalan (Boston University) – Synthesis of core-shell nanoparticles, cell fabrication, electrochemical testing and analysis

Co-PI: Yu Zhong (WPI) – Computational thermodynamics, CALPHAD (calculation of phase diagrams)

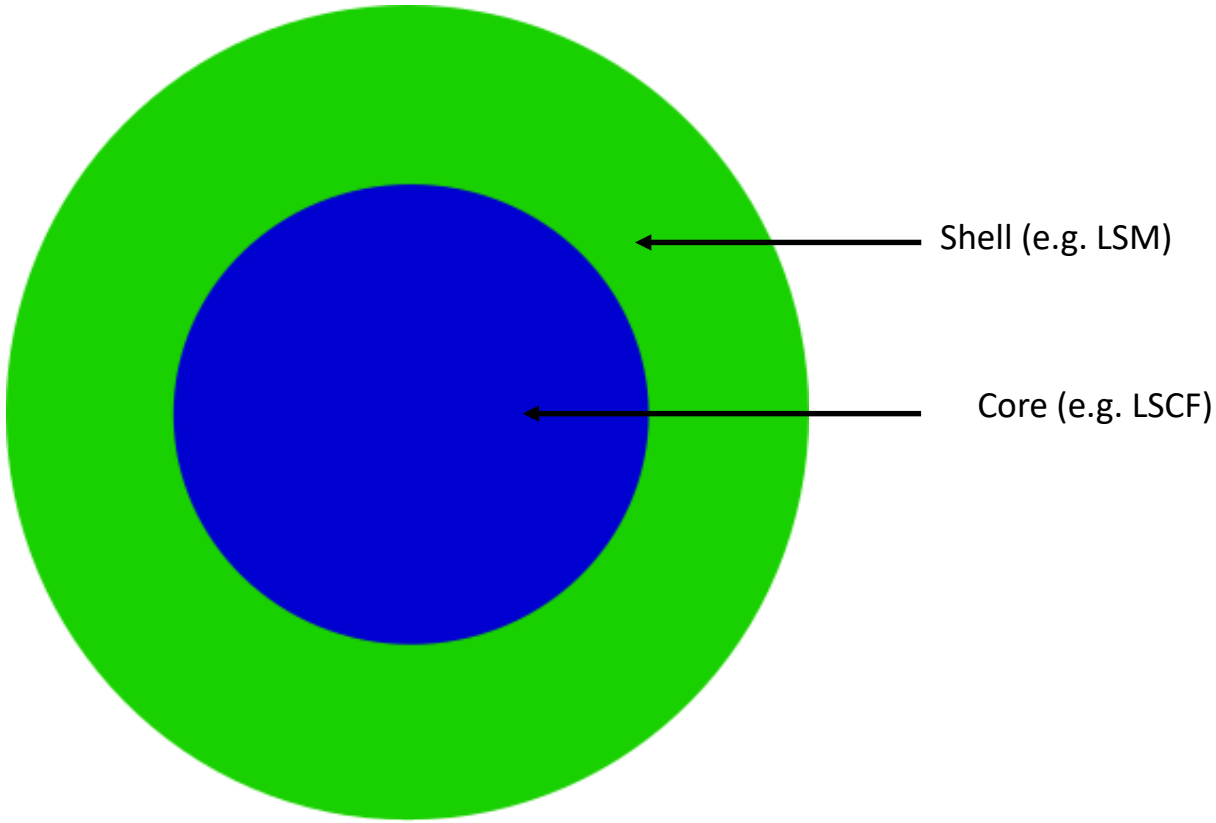
Why core-shell nanoparticles for SOFC cathodes?

- Infiltration of metal salts to form a thin layer of high O_2 – exchange catalysts has proven to be an excellent strategy to reduce cathode activation polarization

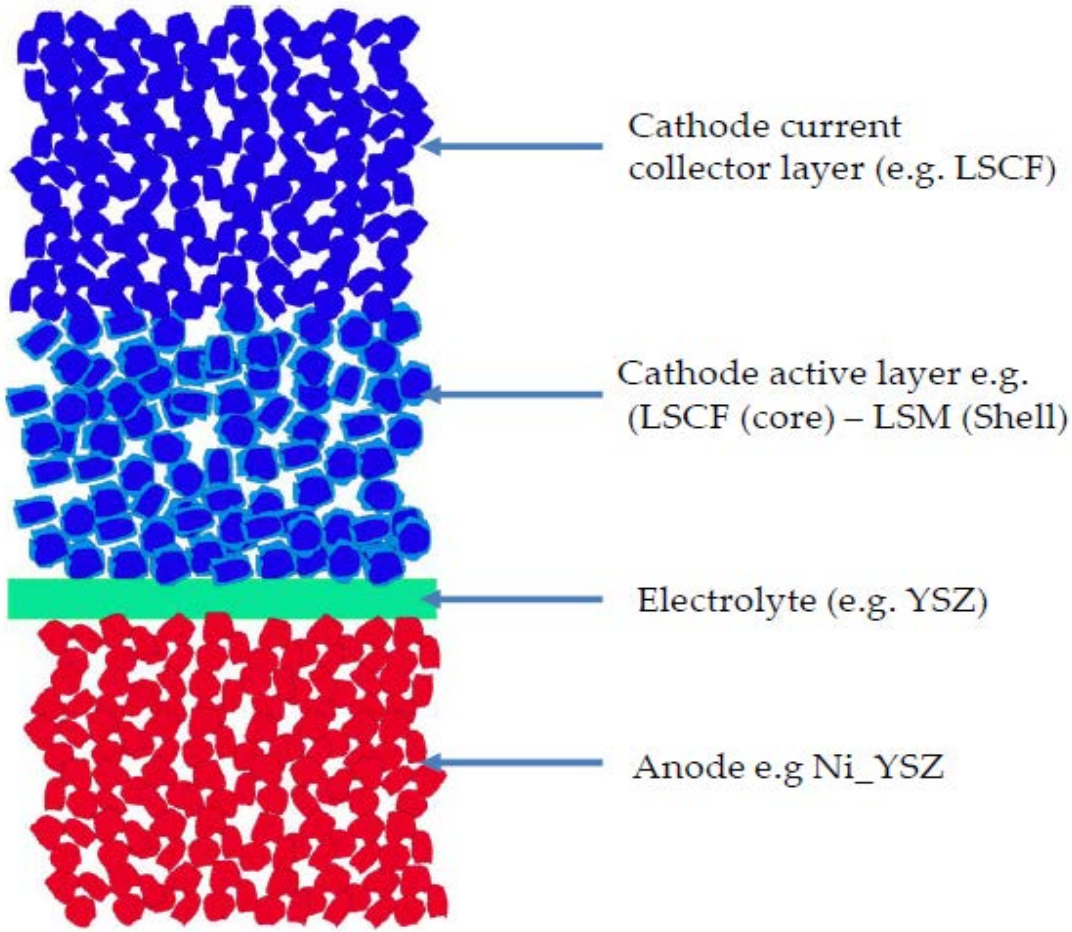
- General idea is – Use MIEC like LSCF as the scaffolding and use a good oxygen adsorber like LSM as the infiltrant; Disadvantage – incomplete coverage of LSM on LSCF

- Solution – heterostructuring at the nanoscale. Core – MIEC such as LSCF and shell – oxygen adsorber such as LSM – thin LSM layer a few nm thick, on a core LSCF support (µm thick)

Core-shell Nanoparticle (CSNP)



Target SOFC Architecture



Objectives

(1) High oxygen reduction rates at lower operating temperatures (600-800°C) resulting in high performance at lower operating temperature (up to 1.5 times power densities measured on baseline cells at 700°C) and simultaneously

(2) Exhibit long-term resistance to Cr-impurity attack induced performance degradation. In particular to reduce the long term degradation rate arising from chromium impurity attack to less than 0.02%/1000 hours

(3) Eliminate necessity for electrode infiltration

Tasks

Task 1.0 - Project Management and Planning (Responsibility Gopalan)

Task 2.0 – Calculation of Phase Diagrams (CALPHAD) (Responsibility Zhong)

Task 3.0 – Synthesis of Core-Shell Particles (Responsibility Gopalan)

Task 4.0 – Fabrication of Single Cells Using Core-Shell powders as Cathode Precursors (Responsibility Gopalan)

Task 5.0 – Electrochemical Testing (Responsibility – Gopalan)

GANTT Chart (Task Schedule)

	Name
1	Project Management and Planning (Responsibility Gopalan)
2	**Calculation of Phase Diagrams (CALPHAD)**
3	CALPHAD of Single Phase Materials
4	CALPHAD of Core-Shell Materials
5	CALPHAD - Thermodynamic Stability of Cathode In-Operando
6	Synthesis of Core-Shell Particles
7	Synthesis conditions for LSCF/LSM, LSCF/LSCM, and LSM/LSCM core-shell particles identified
8	Fabrication of Single Cells
9	Electrochemical Testing
10	Demonstration of 25% improvement using core-shell cathodes compared to baseline cells
11	Demonstration of 35% improvement and less than 0.05%/1000 h degradation using core-shell cathodes
12	Demonstration of 50% (1.5 times) improvement and less than 0.02%/1000 h degradation using core-shell cathodes