**Perovskite Cathodes in SOFCs**

- Solid Oxide Fuel Cells (SOFCs) are high-temperature electricity generating devices.
- Oxygen reduction happens at the cathode side.
- \(\text{La}_{0.8}\text{Sr}_{0.2}\text{FeO}_{3-\delta}\) (LSF) is one of the most commonly used perovskite phase (ABO\(_3\)) cathodes.

**Atomic Layer Deposition (ALD)**

- ALD is a self-limited, film-growth method.
- Changes only the surface composition but not the surface area.

**LSF Surface Study with LEIS**

- Pristine surface composition is affected by preparation temperature.
- All three metal elements are on the surface.
- 5 ALD cycles cannot cover surface.
- 10 ALD uniformly cover all the surface.

**LSF Surface Reaction Blocked by \(\text{ZrO}_2\) and \(\text{Fe}_2\text{O}_3\)**

- Surface modification with A-site metal oxides (AO) are effective, but not with B-Site Oxides (BO\(_2\)) or inert oxides.

**LSF Surface Reaction Promoted with \(\text{La}_2\text{O}_3\) and \(\text{SrO}\)**

- Surface modification of \(\text{La}_2\text{O}_3\) made LSM significantly better, but not LSCo.
- LSCo is much easier to reduce -- has much more surface vacancies than LSM.
- Surface improvement effect via ALD is due to an increment in surface vacancies.

**LSF Growth Rate**

- Growth rate differ with ligand size.
- Approximately, 10 ALD cycles \(\sim\) 1 monolayer coverage.

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