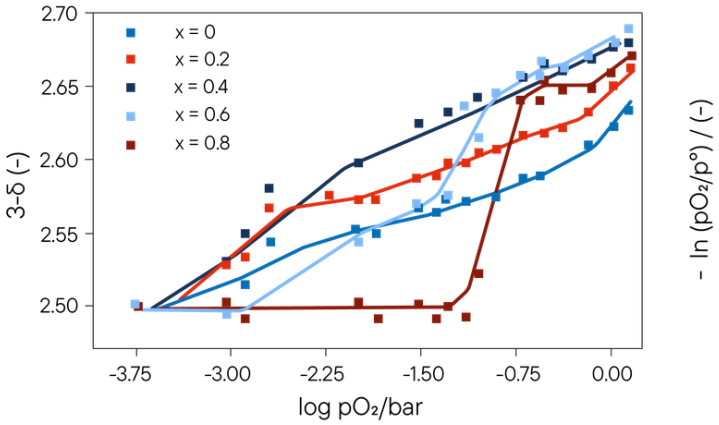
Thermodynamic Characterization of Perovskite Oxygen Carriers Using High-Pressure STA

High-Pressure STA Analysis of Perovskite Oxygen Carriers

Simultaneous Thermal Analysis under controlled oxygen partial pressures provides valuable insights into the oxygen storage and release behavior of perovskite materials. In this application example, substituted $SrFeO_3-\delta$ oxygen carriers were investigated using a Linseis STA HP L85 (formerly Linseis L81 PT High Pressure TGA-DTA/DSC).
The measurements demonstrate the influence of oxygen partial pressure on oxygen non-stoichiometry and reveal the suitability of these materials for chemical looping and oxygen storage applications.

Measurement Setup

- Instrument: Linseis STA HP L85 (former designation: L81 PT High Pressure TGA-DTA/DSC)
- Sample: $SrFeO_3-\delta$-based Perovskite Oxygen Carriers
- Atmosphere: Controlled O_2/N_2 mixtures
- Pressure: Up to 7 bar
- Temperature: 500 °C
- Measurement: Oxygen non-stoichiometry ($\Delta\delta$) as a function of oxygen partial pressure



The high-pressure STA measurement reveals the oxygen storage and release characteristics of different perovskite compositions.
Key observations include:

- Oxygen release increases with decreasing oxygen partial pressure
- Calcium-substituted materials exhibit enhanced oxygen exchange behavior
- Distinct differences between material compositions are observed
- Stable oxygen storage behavior is maintained over a wide operating range

The results demonstrate the strong influence of composition and process conditions on oxygen transport properties.

Interpretation

The observed behavior can be attributed to:

- Oxygen vacancy formation
- Reversible oxygen exchange
- Composition-dependent redox activity

This results in:

- Efficient oxygen storage
- Stable cycling performance

Industrial Relevance

STA HP measurements are widely used for:

- Chemical looping processes
- Oxygen carrier development
- Hydrogen production technologies
- Energy storage materials
- High-temperature reactor systems

Conclusion

The measurements performed with the Linseis STA HP L85 demonstrate the capability of high-pressure simultaneous thermal analysis for characterizing oxygen storage materials under realistic process conditions. The results provide valuable information for the development of advanced oxygen carriers used in chemical looping, energy storage and sustainable process technologies.

Source:
Luongo, G., Donat, F., Müller, C. R.
"Structural and Thermodynamic Study of Ca A- or Co B-site Substituted $SrFeO_3-\delta$ Perovskites for Low Temperature Chemical Looping Applications"
Physical Chemistry Chemical Physics, 2020, 22, 9272–9282
DOI: 10.1039/D0CP01049A
Adapted and extended with measurements performed on a Linseis STA HP L85 (former designation: L81 PT High Pressure TGA-DTA/DSC).