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In situ XAS of ceria redox materials under relevant conditions for solar thermochemical fuel generation

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The conversion and storage of solar energy by generating fuels from H2O and CO2 using thermochemical redox cycles driven by concentrated solar radiation present a viable pathway towards a sustainable and environmentally benign energy future.
A two-step cycle based on non-stoichiometric ceria that requires challenging operation conditions - typically 1773 K for the reduction and 1073 K for the oxidation step - has recently been demonstrated.
Both thermodynamic properties and the kinetic performance are crucial for the design of advanced materials for enhancing process efficiency. The introduction of dopants into the fluorite-type
ceria lattice strongly affects the non-stoichiometry, which is pivotal for the efficiency of the process. In order to establish relationships between structure, oxygen storage capacity, reaction kinetics and stability, a high temperature flow cell for in situ XAS under relevant conditions has been built. In the same setup, the kinetics of the H2O splitting reaction with doped ceria materials and Pt/ceria have been determined. XAS at the Ce K edge allows determining the Ce(III)/Ce(IV)-ratio at temperatures up to 1773K.
In the light of these extreme conditions, the opportunities and limitations of in situ XAS are discussed.

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