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Optimization of Ca1-xSrxMnO3 ceramic foams for high-temperature thermochemical energy storage

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$CaMnO_3$-based perovskite ceramics are highly attractive for thermochemical energy storage applications due to their thermal stability, stable redox-cyclability, low cost and high energy storage density. In order to unfold their potential in next generation high-temperature storage systems for concentrated solar thermal technologies and industrial heat recovery, optimization regarding composition and microstructure is required. Extending prior work of the authors group demonstrating that stable reticulated porous foams of $CaMnO_3$ can be produced and cycled thermally with significant heat storage density[1], a comprehensive study on optimized foams of $Ca_{1-x}Sr_xMnO_3$ ($0 < x < 0.1$) is presented here, thriving to deepen the understanding of their redox cyclability and its effect on microstructure, crystallinity and mechanical strength. Sr-doped foams did not reveal any structural degradation and exhibited reproducible oxygen uptake and release over 300 cycles between 300°C-1100°C in air. XRD analysis after cycling indicated no secondary phases and slightly altered unit cell parameters indicating residual lattice expansion. SEM-analysis did not show any significant grain growth and no formation of microcracks was observed. The findings are correlated to mechanical properties of foams as a function of synthesis and shaping parameters like Sr dopant concentration, sintering temperature and porosity.

1. M. Pein et al., ''Reticulated porous perovskite structures for thermochemical solar energy storage'', Advanced Energy Materials, 12(10), 2102882, 2022.