

Formation and stabilization of Sn@SnO_x molten nanoparticles on ceria in a SOFC anode

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Cerium oxide has received considerable attention in the development of IT-SOFC anodes due to its relatively high ionic conductivity and its oxidizing properties at temperatures as low as 873 K. In order to optimize cell performance, its electronic conductivity and catalytic properties are usually enhanced by using a metal co-catalyst. In this regard, tin has not been investigated yet, despite its low cost and its demonstrated catalytic activity towards CO and H₂ oxidation when combined with ceria.¹ In this study the redox interaction between tin oxide and ceria is studied in view of developing a new SOFC anode.

Samarium doped ceria (SDC) electrolyte supported cells were prepared by pressing, the porous anode was co-sintered with the electrolyte and infiltrated with different ratio of ceria and tin. Table 1 shows the compositions investigated. Materials and cells were characterized through SEM, HRTEM techniques and with XRD and XPS in-house analysis. The electrochemical behavior was investigated by electrochemical impedance spectroscopy (EIS) measurements and by registering potential/power-current density curves.

Table 1. Compositions of cells tested

	Ceria (Weight %)	Ceria (Weight %)	Ce:Sn (molar ratio)
Cell A	20	0	-
Cell B	0	12	-
Cell C	20	6	3
Cell D	20	12	1.5

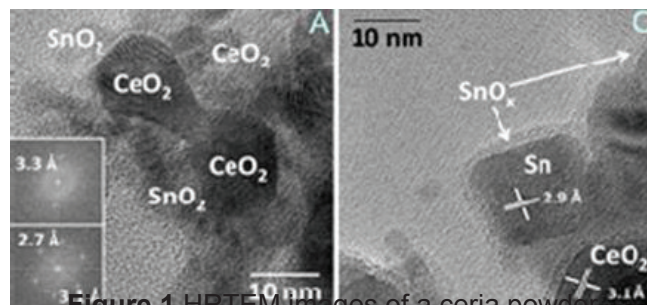


Figure 1 HRTEM images of a ceria powder infiltrated with tin oxide (A) before and (C) after exposure to H₂ at 873K for 6 h.

It was found that the presence of tin in ceria infiltrated SOFC anodes enhances the electrocatalytic properties of ceria towards the oxidation of hydrogen at 873 K, causing up to a 10-fold increase in power output for cell D. HR-TEM experiments revealed that the molten tin is stabilized in molten metal core-shell nanostructures on ceria particles (Figure 1). The stabilization is possible thanks to a fast transfer of oxygen from ceria to the tin nano-particles and the formation of an amorphous oxide on their surface, which avoid coalescence. Further studies are necessary to gain insights into the actual composition of tin-ceria interface and its role on the activity of the electrode. These findings highlight that metal oxides supported on ceria under controlled reducing conditions may give rise to a self-assembly of more reactive surfaces when the temperature is risen above the melting point of the catalyst. This could constitute a model for alternative syntheses towards multi-functional catalysts and active heterostructures.

Reference

1. C. Chatzichristodoulou, P. Blennow, M. Sogaard, P. Hendriksen, M. Mogensen, in: (A. Trovarelli, P.Fornasiero, Eds.), *Catalysis by ceria and related materials*, Imperial College Press London, 2013.
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