Nanocomposites and nanomaterials

Influence of treatment temperature on microstructure and properties of YSZ-NiO anode materials

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Solid oxide fuel cells (SOFCs) are devices which can convert the chemical energy of fuel into electrical energy cleanly and with a high electrical efficiency. Typical operation temperatures of SOFCs are 700–1000°C. Operation at these temperatures causes significant thermal stresses. There are ongoing efforts to lower the operating temperature to 500–600°C.

Typical SOFC anodes are fabricated from a nickel oxide/yttria-stabilized zirconia (YSZ) ceramic composite and are reduced in situ, during operation, to form a Ni/YSZ cermets. However, the nickel component of the anode may reoxidize in SOFC for various reasons, such as the disruption of the fuel supply at operating temperatures. In order to use a reoxidized cell, it must be reduced once more. Thus, cyclic reduction and oxidation (redox) of the anode can occur during SOFC operation.

The aim of this work is to develop a possible method to minimize the physical and mechanical degradation of YSZ–Ni anode-supported SOFCs caused by redox cycling at high temperatures in air.

It is known that in the temperature range 630…680C transition from diffusion to kinetic mechanism of oxidation is occurred. Contrary to negative effect of redox treatment of NiO and YSZ-NiO ceramics at 800°C, a positive tendency for strength of YSZ-NiO ceramics during the treatment at 600°C is noted.

Using the treatment temperature 600°C the structure providing improved physical and mechanical properties of the material was formed. However, at the treatment temperature 800C the anode structure with the array of microcracks was formed that reduced significantly the strength and electrical conductivity of the material. Based on the data of thermodynamics and X-ray analysis the obtained results were related with influence of temperature rise on intensification of nickel

oxidation and increase of residual stresses.