

Densification, Microstructure and Electrical Conductivity of Yttria – Stabilized Zirconia Containing Small NiO Additions

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Abstract – The effects of the addition of small contents of NiO on densification, microstructure and electrical properties of yttria-stabilized zirconia were studied in detail. Pellets were sintered at several dwell temperatures and soaking times. Sintered pellets were analyzed by X-ray diffraction, dilatometry, apparent density, scanning electron microscopy, impedance spectroscopy and helium pycnometry. The addition of NiO improved the densification and increased the mean grain size. The grain conductivity did not change by the addition of NiO on yttria-stabilized zirconia, whereas the grain boundary conductivity slightly decreased.

Yttria-stabilized zirconia (YSZ) is the most developed solid electrolyte for SOFC applications along with Ni/YSZ cermet, which is the preferred anode material [1]. Several works have been done to elucidate the interaction of YSZ and the NiO, but they are not consistent at all. Linderoth and coworkers [2] verified that the conductivity of YSZ decreased by the addition of small contents of NiO. Although, Van Herle and Vasquez [3] did not verify that decrease on conductivity. Besides that, the effects of small additions of NiO on densification and microstructure of YSZ have not been reported yet. In this work the effects of small NiO additions on densification, microstructure and electrical conductivity of YSZ were investigated in detail.

Nickel hydroxycarbonate was added to commercial YSZ (Tosoh, Japan) to give between 0.46% and 5.0% NiO mol. Sintering of powder compacts was carried out at several dwell temperatures and soaking times. The pellets were analyzed by X-ray diffraction (XRD), dilatometry, helium pycnometry, Raman spectroscopy, scanning electron microscopy (SEM) and impedance spectroscopy.

The solubility limit of NiO in YSZ at 1350°C estimated by XRD is 1.6 mol%. Cubic NiO was the secondary phase formed when the additive exceeds the solubility limit, as determined by Raman spectroscopy. The dilatometry analyzes and the apparent densities results showed that the addition of small contents of NiO on YSZ improved the densification. The mean grain size was increased by the addition of NiO on YSZ. The grain conductivity does not change with additive up 1 mol% independent on the soaking time. The grain boundary conductivity varies slightly with the content of NiO, and is higher for the NiO free-samples.

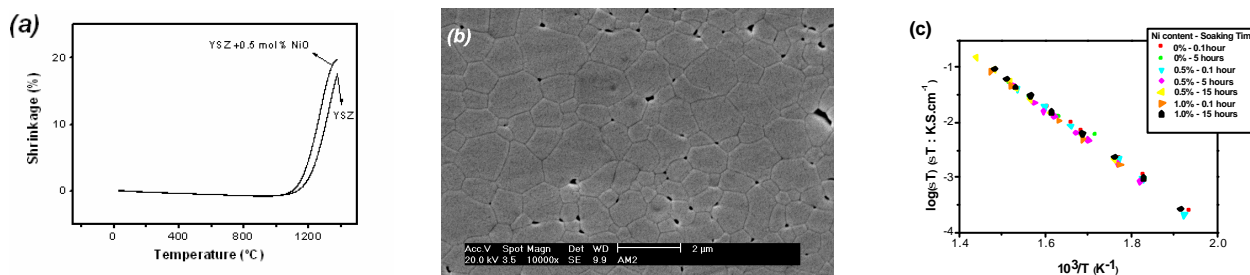


Figure 1: (a) Shrinkage versus temperature for YSZ and YSZ + 0.5 mol % NiO as determined by dilatometry, (b) SEM image of YSZ + 0.5% mol NiO sintered at 1350°C for 0.1 hour, and (c) Arrhenius plots of the grain conductivity for several soaking times and different NiO contents.

References

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