Gas Sensors Based on Nanocrystalline Oxides

The goal of this study is to develop basis for fabrication and design gas sensors based on nanocrystalline oxides thin films. The advantages of such devices are related to enhanced properties of nanocrystallne materials, which electrical transport and diffusivity are attributed to grain boundary phase. It has been shown that nanocrystalline ceramics with grain size < 100nm offer exciting potential for developing electrochemical sensors with superior performance. Recent experimental studies have shown that electrical conductivity can be markedly increased in nanocrystalline ZrO_2:Y_2O_3, ZrO_2:Sc_2O_3, $SrCeO_3$:Yb_2O_3 and CeO_2 systems. These observations offer exciting implications for a number of applications where high conductivity and the interaction between the solid and the ambient atmosphere are required. This would include not only gas sensors but also ionic and mixed electronic-ionic conductors for batteries, fuel cells and ionic membranes.

Enabling Technologies and Experiments:

- processing of nanocrystalline oxide thin films by polymeric precursor spin coating method with controlled thickness (up to 2μm) and microstructure (2 - 400nm), clean room (100 class) and spin coating facilities

- the study of electrical conductivity of thin films and bulk specimens as a function of temperature and oxygen activity (1-10^{-30}atm) with a ability to evaluate material stoichiometry and reaction kinetics rates, impedance spectrometer Solartron 1260 with 1294 and 1296 interfaces, Solartron 1287 Potentiostat.

- Raman spectroscopy to evaluate the defect concentration and lattice disorder, Jobin Yvon

References

1. I.Kosacki and H.U.Anderson – "Grain boundary effects in nanocrystalline oxide thin films" in Encyclopedia of Materials: Science and Technology, Elsevier Science Ltd., New York 2001, vol.**4**, pp.3609-3617.
2. I.Kosacki and H.U.Anderson, Sensors and Actuators **B48** (1998) 263.
3. I.Kosacki, T.Suzuki and H.U.Anderson, Solid State Ionics **136/137** (2000) 1225.
4. I.Kosacki, T.Suzuki, H.U.Anderson, Solid State Ionics **149** (2002) 99.
5. T.Suzuki, I.Kosacki, H.U.Anderson, Solid State Ionics **151** (2002) 111.
6. I.Kosacki, Ph.Colomban, H.U.Anderson, J. Am. Ceram. Soc. **85** (2002) 2646.
7. I.Kosacki, H.U.Anderson, Y.Mizutani, K.Ukai, Solid State Ionics **152/153** (2002) 431.

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