

Oxygen Diffusion in Nanocrystalline Yttria-Stabilized Zirconia

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Yttria-stabilized zirconia (YSZ) is used in diverse applications because of its high oxygen ionic conductivity. YSZ ceramics and thin films show enhanced oxygen conductivity [1-3] but the reason for the enhancement and the nature of the mobile species remain unclear.

In this work we used ¹⁸O/¹⁶O exchange and SIMS to examine the transport of oxygen in dense nanocrystalline samples of YSZ, as well as in single crystals of similar yttria content. SIMS (secondary ion mass spectrometry) measurements were made on a Time-of-Flight-SIMS machine [4]. Oxygen diffusion coefficients (D^*) and oxygen surface exchange coefficients (k^*) were measured for temperatures $673 \leq T/K \leq 973$ at an oxygen partial pressure of 900 mbar. No evidence is found for fast diffusion along grain boundaries. Rather, the analysis indicates that grain boundaries hinder oxygen transport [5].

References

- [1] U. Brossmann, G. Knöner, H.-E. Schaefer, R. Würschum, Rev. Adv. Mater. Sci. 6 (2004) 7.
- [2] G. Knöner, K. Reimann, R. Röwer, U. Södervall, H.-E. Schaefer, PNAS 100 (2003) 3870.
- [3] I. Kosacki, C. M. Rouleau, P. F. Becher, J. Bentley, D. H. Lowndes, Solid State Ion. 176 (2005) 1319.
- [4] R. A. De Souza, J. Zehnpfenning, M. Martin, J. Maier, Solid State Ion. 176 (2005) 1465.
- [5] R. A. De Souza, M. J. Pietrowski, U. Anselmi-Tamburini, S. Kim, Z. A. Munir, M. Martin, Phys. Chem Chem Phys. 10 (2008) 2067.