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Thermal Diffusivity of Sintered $12CaO \times 7Al_2O_3$

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Introduction

-transparent insulating oxide $12CaO \times 7Al_2O_3$ (C12A7) [1] can be transformed into an electrical conductor by ion doping
-Incorporation of hydride (H^-) ions into cages of the nanoporous lattice framework of the oxide by thermal treatment in a hydrogen atmosphere lead to complex behaviour in electrical conductivity of this crystal [2].
-Subsequent irradiation of the material with UV light results in a conductive state that remains so after irradiation is over.
-Hydrogen differs from a conventional donor center as electron capture and release processes are accompanied by migration and a chemical reaction

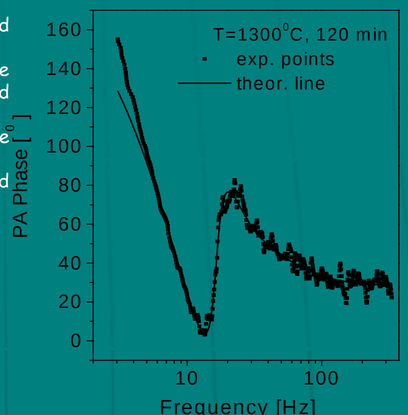


Fig. 2. The calculated and experimental phase diagrams for a C12A7 sample sintered in hydrogen for 120 minutes

Numerical analysis of all experimental results was done using a modified Rosencwaig-Gersho thermal piston model. One typical phase diagram is given in Fig 2.

Experimental

➢Preparation of $CaCO_3$ and Al_2O_3 powders:

- Ball milling 120 min powders of $CaCO_3$ and Al_2O_3
- Pressing 1000kg/cm^2 discs 10 mm in diameter
- Sintering conditions (1300^{0}C –30, 60, 120, 240 min) in air or hydrogen
- Exposure to UV light the samples sintered in H_2

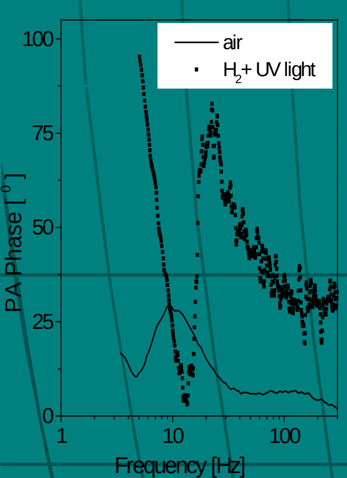
➢Photoacoustic (PA) phase and amplitude spectra were measured using a transmision detection configuration
➢red laser (Mitsubishi Electric Corp ML 120G21-01, 80 mW)
➢Stanford SR 850 phase detector

Numerically determined parameters for C12A7 samples sintered for different times in air and hydrogen followed by UV treatment

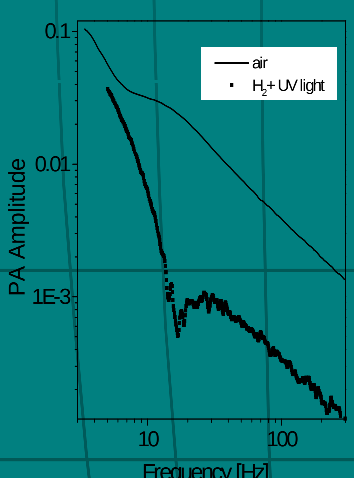
Sample	1	2	3	4	5	6
Way of sintering	Air	Air	Air	H_2+UV	H_2+UV	H_2+UV
Sintering time *t*[min]	30	120	240	60	120	240
d [μm]	650	670	590	660	720	730
D_T [m/s]	2.7×10^{-7}	1.8×10^{-7}	1.9×10^{-7}	4.3×10^{-7}	3.5×10^{-7}	2.9×10^{-7}
D [m/s]	2.1×10^{-7}	2.4×10^{-7}	3.0×10^{-7}	4.7×10^{-8}	6.7×10^{-7}	3.1×10^{-6}

Results

The change of thermal diffusivity and free carrier diffusion coefficient with the sintering time was analyzed:

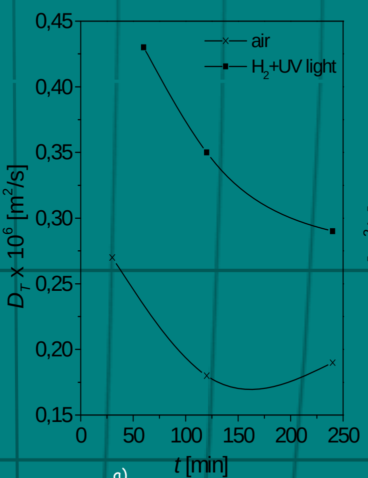


a)

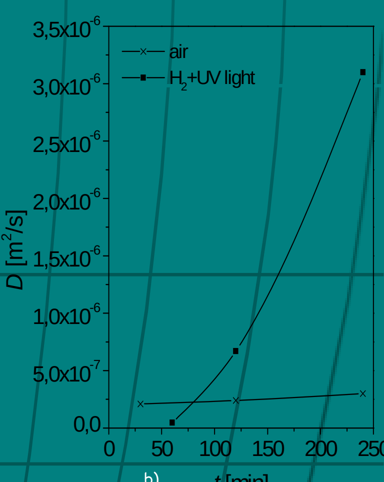


b)

Fig.1. PA phase and amplitude diagrams versus the modulating frequencies for two typical C12A7 samples sintered for 120 minutes in air (a) or in hydrogen and further treated with UV light (b)



a)



b)

Fig.3. Thermal diffusivity D_T(a) and diffusion coefficient of free carriers , D(b) versus the sintering time for samples sintered in air and hydrogen followed by UV treatment

References:

1. K. Hayashi, P. V. Shushko, A. L. Shluger, M. Hirano, H. Hosono, *J. Phys. Chem.* **109**:23836 (2005).
2. Peter V. Sushkoef, *Phys. Rev. B* 73 , 014101,(2006)