

Influence of Crystallization on the Electronic Conductivity of Iron Phosphate Glasses

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Electronically conducting glasses of the composition $43\text{Fe}_2\text{O}_3\text{-}57\text{P}_2\text{O}_5$ were analyzed by Raman spectroscopy, XRD analysis and scanning electron microscopy (SEM). The main crystalline phases formed during thermal treatments are $\text{Fe}_3(\text{P}_2\text{O}_7)_2$, FePO_4 and $\text{Fe}_4(\text{P}_2\text{O}_7)_3$ [1]. The effects of the annealing of iron phosphate glasses on their electrical conductivity were studied by impedance spectroscopy. The electrical conductivity was measured for as-quenched glass and after thermal treatments up to 804. The presence of crystalline $\text{Fe}_3(\text{P}_2\text{O}_7)_2$ grains formed after thermal treatment at temperature close to the first crystallization temperature, T_{C1} , 590 °C, enhances the electrical conductivity as compared with the as-quenched glass. This conductivity enhancement is related to the conduction at the interfaces between the crystallites and glassy phase [2]. Further thermal treatment at higher temperature, T_{C1} , 724 °C and 804 °C leads to formation of ferric orthophosphate, FePO_4 along with pronounced growth of $\text{Fe}_4(\text{P}_2\text{O}_7)_3$. Electrical conductivity of this glass-ceramics decreases. The decrease in electrical conductivity is explained by a considerable weakening in the interactions between Fe sites in crystalline glasses, caused by poorly defined conduction pathways. This is result of the presence of larger crystalline grains and disappearance of glassy matrix in fully crystallized sample. Formation of microcrystallites causes a drop in conductivity due to the reduction of grain boundary region suggesting that the conductivity depends on the electron hopping in crystalline phases.

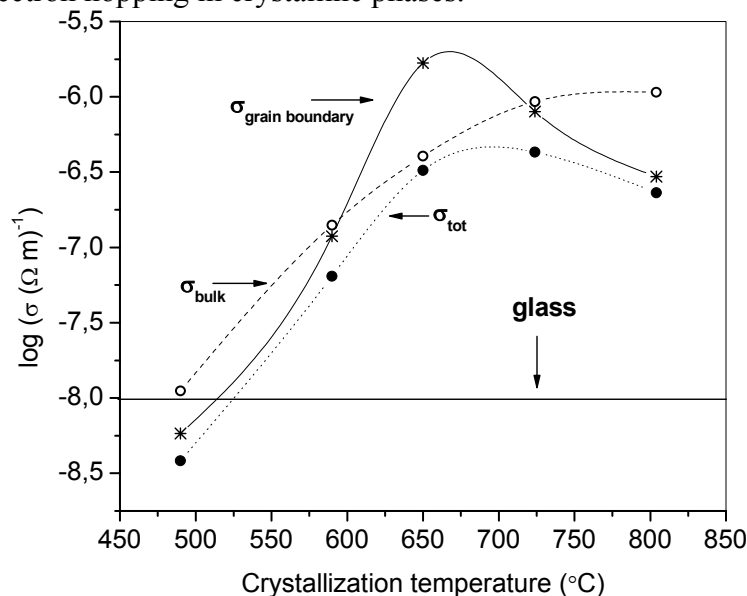


Fig. 1: Dependence of electrical conductivity of the grains, grain boundaries and total electrical conductivity upon the temperature of thermal treatment of the crystallized samples

[1] A. Moguš-Milanković, M. Rajić, A. Drasner, R. Trojko, D.E. Day, *Phys. Chem. Glasses* 39 (1998) 70-75.

[2] B. Roling, S. Murugavel, *Z. Phys. Chem.* 219 (2005) 23-33.