Nanocomposites and nanomaterials

Electrical Conductivity Processes in Trasition Metal Oxide Glasses Containing Nanostructures

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A concise survey of electrical conductivity and relaxation processes in glasses containing transition metal oxides is presented. The influence of the nanostructure of glasses on electrical properties is determined. Electronic and electronic-ionic conductivity mechanisms are analysed. D.c. and a.c. electrical conductivity data on a range of transition metal oxide (TMO) glasses shows that a polaronic model of conductivity is generally applicable. It is shown that both ac and dc conductivity processes are due to the same mechanism. Amorphous and crystalline nanostructures dispersed in the bulk matrix of the glass influence their properties and give rise to electrical relaxation processes. On the basis of Jonscher *universal dielectric response* we have determined that in structured glasses two different conduction mechanisms may coexist: small - polaron hopping and electron or large - polaron tunneling (between nanostructures).

By applying a scaling procedure it is possible to obtain universal conductivity curve and to find the relation between ac and dc activation energy. Complex plot of electric modulus gives a simple method of scaling analysis.

An classification of mixed electronic-ionic behavior in TMO containing alkali ions was performed on the basis of impedance spectroscopy. A deep minimum of conductivity at certain content of alkali ions is observed in glasses where TMO is a glass former. Two different behaviors can be distinguished in glasses where TMO is a glass network modifier. In glasses containing iron oxide electrical properties are only slightly influenced by alkali ions. A mixed electronic-ionic conduction is observed in glasses containing copper oxides.