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Specific feature of mixed alkali effect in the a.c. conductivity of ion-conducting glasses

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Abstract

We discuss a new mixed alkali effect observed recently in the dynamic conductivity (in the frequency range from GHz to THz) of ion-conducting glasses. The parameters of a supra-linear power law that describes the dispersive a.c. conductivity are mutually interconnected to yield a concentration independent phenomenon. The latter could probably constitute a universal behaviour of non-hopping lattice relaxation.
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The influence of relative cation contents in ion conducting mixed alkali glasses, as the overall cation content remains constant, on the electric charge transport is attracting the interest of current research [1–4] . The a.c. conductivity spectrum of glassy systems consists of a low frequency contribution, which is linked to the hopping motions of the mobile cations, and a non-hopping response that dominates in the high-frequency region (up to THz frequencies) that involves both the mobile ions and the glassy network [4].

Cramer et al [4] have investigated the role of non-hopping phenomena, which are probably related with the network dynamics, on the dynamic conductivity of mixed alkali glasses by using complex impedance measurements ranging from mHz to THz frequencies,. The dependence of the non-hopping a.c. conductivity ó$_{\mathrm{ac}}$ on the frequency of the external electric field obeys a power law:

$$\sigma_{\mathrm{ac}} = A\nu^{q} \tag{1}$$

with $q>1$. Such supra-linear power law increase of the frequency dependent conductivity in GHz to THz electromagnetic fields is observed (in addition to the Jonscher's universal dielectric response [5]) in many different disordered materials [3]. However, Cramer et al. [4] verified that the non-hopping contributions follow a new mixed alkali effect. The parameters A and q are sensitive to the glass composition; a minimum in logA is accompanied with a maximum in q as a function of the glass composition.

These results also imply that the ratio log A/q does not depend on the composition. In Fig. 1, the ratio log A/q vs. x

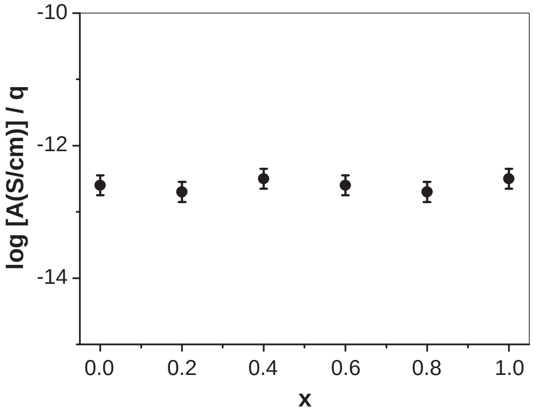

Fig. 1. The composition dependence of the ratio log A/q for non-hopping dynamic conductivity in glassy 0.3[xLi$_2$O.(1−x)Li$_2$O] 0.7B$_2$O$_3$.

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for glassy $0.3[x\mathrm{Li_2O}.(1-x)\mathrm{Li_2O}]\ 0.7\mathrm{B_2O_3}$ is depicted. We observe that, within the experimental errors, log A/q holds a practically constant value -12.6 (the parameter A is in S/cm units). Such behavior can hardly be accidental and is probably a specific characteristic of the non-hopping process. Experiments on different glassy systems are desirable so as to see whether the constancy of the ratio log A/q is a universal law in non-hopping phenomena.

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