
Poled glasses: relaxation and surface relief formation

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Abstract

Thermal poling of glasses, that is, applying several hundred volts DC to a glass plate glass placed between two electrodes, heating it up to a temperature sufficient to activate ionic conductivity, and subsequent cooling under the applied voltage, results in structural and compositional modifications of multicomponent glasses. These modifications lead to relaxation of the glass structure and change of their surface reactivity. We present studies of a) relief formation on the surface of differently poled soda-lime glasses because of their volume relaxation in the course of poling and secondary heat treatment; b) compositional/structural and chemical reactivity relaxation under the secondary heat-treatment of these glasses; c) thermally stimulated depolarization current (TSDC) of "frozen" electric charge relaxation. Profilometry of the step at the interface of poled and unpoled glass surface allowed us to see the relation between the electric charge transferred in the course of the poling and the height of the surface relief formed and to reveal the peculiarities corresponding to higher poling voltages and poling conditions. Temporal behavior of the step under the secondary heat treatment allowed characterizing volume relaxation processes occurring under the heat treatment. Studied influence of the secondary heat treatment on the composition/structure and etching rate of the poled glass region provided us with the information on relaxation processes occurring under thermal processing of the poled glasses. The TSDC studies brought out three temperature regions which we attributed to the relaxation via 1) a turn of non-bridging oxygen bonds (250-300K range), 2) cation migration (600-700K range), and 3) switching of the oxygen bonds (viscous flow temperature range, 900 – 1000K range). Additionally, etching of the glasses with the use of poled region as a mask was applied for the formation of the surface relief essentially higher than one formed due to the volume relaxation in glass poling. The study has been supported by Russian Science Foundation grant No. 16-12-10044.

Keywords: sodalime glass, poling, thermal treatment, relaxation, TSDC, etching

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