Mechanical strength improvement of a soda-lime-silica glass by thermal treatment under flowing gas

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The nitridation of silicon dioxide films by Chemical Vapour Deposition (CVD) routes has been extensively studied in the recent years for its great technological interest in semiconductor science [1]. In contrast to SiO_2, silicon nitride and silicon oxynitride films have excellent diffusion-limiting properties and therefore exhibit a protective action against corrosion, oxidation and impurity diffusion. Although nitridation is commonly used to improve the mechanical performances of iron steels [2], few papers only studies nitridation of silicates glasses surfaces [3].

In this study, thermal treatments of a soda-lime-silica glass under different atmospheres (air, N_2 and NH_3) were conducted by flowing gas trough a silica tube placed into an electrical furnace. Nitrogen content gas treatments create compositional changes in the near surface: SIMS and XPS techniques revealed significant alkali depletion and a limited nitrogen penetration respectively. FTIR-reflexion spectroscopy [4] was used to follow the displacement of the Si-O stretching band, from 1056 cm^{-1} to 1110 cm^{-1}, giving evidence for compositional changes from typical soda-lime glass towards a near silica glass composition.

The hardness and the fracture toughness of glasses were measured by the indentation technique as a function of heat-treatment time and temperature. In addition, nanoindentation investigations were carried out using an atomic force microscope set-up. The fracture strength measurement was carried out using a four-point bending test.

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