Calculation of residual stress in Alkali-Silicate glasses after Ion Exchange

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Abstract

Chemical strengthening by ion exchange is becoming a widely used technology to increase glass strength . Structural applications of glass in consumer electronics, transportations, and architecture has generated a significant increase of interest in glass chemical strengthening by ion exchange. The determination of residual stress profile induced by ion exchange is of critical importance in process design and final product assessment. Experimental methods and international standards are generally limited to the determination of surface compression (Sc) and compression layer depth (Cd).Mathematical modeling, when compared with experimental results, can be useful to check our understanding of the physics and chemistry of the ion exchange process. Predictions of stress profile based on mathematical models have been proposed in the literature. Here it is presented an approach to mathematical modeling of residual stress profile considering: ion exchange kinetics, stress relaxation, constant and concentration dependent Linear Network Dilatation coefficient (LNDC – B). Applications examples to soda-lime silicate glass will be presented and discussed. A short discussion of effects due to time dependent boundary conditions for ion concentration will also be presented. A side discussion will be introduced on the "zero time surface compression value" and its connection to the recently debated LNDC anomaly. A final discussion will also be proposed for glass strength assessment on the basis of a calculated stress profile.

Keywords: Chemical strengthening, Ion Exchange, Residual Stress profile, Mathematical modeling, Strength

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