Effect of glass alteration on silver speciation in a phase separated glass

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Abstract

Diffusion on glass material plays a key role in industrial and geological processes. Interdiffusion mechanisms are at the core of ion exchange processes, notably employed for modifying the surface properties of glasses (mechanical reinforcement, gradient in refractive index, glass coloration...). One of the challenges facing glass as a material for a sustainable future is a better control and use of these processes to reach new glass properties and improve their life cycle.
Many models and mechanisms have been developed and gives us a better understanding on how diffusion works. However, few experimental studies have been reported so far on the diffusion of ions in a heterogeneous media. The present study investigates how heterogeneities in composition impact the interdiffusion of metallic ions.

The present work consists in investigating the diffusion mechanisms in a borosilicate glass separated in two phases: a silica-rich one and a sodium-boron-rich one. Firstly, we explore the diffusion of silver ions through ion exchange, employing the salt bath method. Silver is mainly present in the boron-sodium rich phase, which is highly sensitive to the ambient humidity. Interaction between the silver-doped glass and ambient humidity leads to structural changes mainly in the boron-sodium rich phase: the silver, mainly in ionic form after diffusion, tends to precipitate into metallic nanoparticles through time. Experiments have shown that the size and distribution of the nanoparticles depend on the initial phase separation pattern, the conditions of storage and the ionic exchange conditions.
Our work mainly focuses on understanding how the differences in composition, chemical and physical properties between the two phases impact the diffusion of silver metallic ions, as well as their reduction and precipitation in nanoparticles.

Keywords: Phase separation, Glass Alteration, Silver, Nanoparticles

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