Silicate glass structures with low hydrogen permeability

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Abstract

Efficient energy provision using fuel cells requires effective hydrogen storage capacities. Glass is a material of low intrinsic hydrogen permeability and is therefore a promising material for hydrogen storage containers or diffusion barriers. Pioneer work on oxidic glasses seems to indicate a correlation between glass composition and hydrogen permeation, which was mainly derived from the behavior of silica glass. In this study, we focus on the relationship between topologic (free volume; network polymerization) and thermodynamic (configurational entropy) glass parameters. Experiments were performed well below the glass transition temperature, which excludes significant structural relaxation and chemical dissolution of hydrogen. The compositional dependence of seven glasses on the SiO2-NaAlO2 join pointed out that in fully polymerized glasses the H2 permeability cannot be solely derived from the total free volume of the glass structure. Hence, evidence is provided that the size distribution of free volume contributes to hydrogen diffusion and solubility. Additionally, results indicate that hydrogen permeability of the glasses is affected by the configurational heat capacity ΔCp at Tg.

Keywords: hydrogen permeability, sodium aluminosilicate

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