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Formation of SiO$_2$-Rich Surface Layer on Glass Fibers

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Man-made amorphous stone wool fibers are widely used for thermal and sound insulation and as a fire barrier. The applications of the glass fibers are influenced by their chemical and mechanical properties and high temperature stability (HTS). In this work, we study the surface modification of iron-bearing aluminosilicate glass fibers by using an internal diffusion process to change the chemical composition of the fiber surface. It is found that reduction of Fe$^{3+}$ to Fe$^{2+}$ results in diffusion of network-modifying cations from the surface toward the interior of the fibers. Consequently, a silica-rich surface layer is created. The extent of the inward diffusion increases with the degree of Fe$^{3+}$ reduction, and the latter can be varied by changing the duration and temperature of the heat-treatment. We demonstrate the impact of the surface modification on the crystallization behavior, HTS, and chemical durability of the fibers.