

AMORPHOUS MATERIALS: PROPERTIES, STRUCTURE, AND DURABILITY

The nearly complete dissociation of water in glasses with strong aluminum avoidance†

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ABSTRACT

Water is dissolved in silicate glasses and melts as hydroxyl groups and molecular water, with mostly hydroxyl groups at low water contents and mostly molecular water at high water contents. However, we recently predicted that water will be dissociated nearly completely in potassium aluminosilicate glasses with more alumina than silica because of the strong aluminum avoidance and the strong tendency for Al-O-Al linkages to hydrolyze in such glasses. In the present study, I test this prediction on hydrous $K_2Al_2SiO_6$ glasses: the Raman and infrared absorption spectra show that water is indeed predominantly present as hydroxyl groups, even for glasses with more than 7 wt% water. This observation validates the previously proposed speciation reactions, demonstrates that variations in water speciation are related to the nature of the cations to which the hydroxyl groups are bonded, and indicates that the classical picture of water dissolution, with predominantly molecular water at high water contents, may not apply near compositional extremes.

Keywords: Potassium aluminosilicate glasses; Raman spectroscopy; infrared absorption spectroscopy; water speciation; aluminum avoidance