

Abstract: Incorporation of rhenium into borosilicate glasses

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The present study aims at providing structural data on rhenium in borosilicate glasses. Glasses containing various targeted Re_2O_7 concentrations— added as crystalline NaReO_4 precursor (Re^{7+}) — were produced. For our melting conditions, it was found by X-ray Absorption Spectroscopy (XAS) and Raman spectroscopy that rhenium was in +VII oxidation state as perrhenate anion (ReO_4^-), having a tetrahedral geometry. Local environment around perrhenate tetrahedra was also investigated by Raman spectroscopy as a function of glass composition and melting temperature. It was shown that the symmetric stretching band of the Re-O bond ($\nu_1^{\text{Re-O}}$) was sensitive to perrhenate environment and that it was different from the one found in pure crystalline alkali perrhenates. Furthermore, it was shown that $\nu_1^{\text{Re-O}}$ shifts were dependent on the nature and the content of alkali cations present in the glass. This indicates a mixed contribution of network modifying cations around perrhenate (ReO_4^-). On the other hand, Raman spectroscopy provides evidence that melting temperature has no significant effects on perrhenate Raman spectra features. It is the first time that such a kind of results was obtained for these compositions. Eventually, these results are consistent with the only data available in literature on the incorporation of rhenium in borosilicate glass for another composition range [Midorikawa et al., 2022] which could be seen as a general behavior. Multinuclear solid-state NMR (^{11}B , ^{27}Al , ^{29}Si , and ^{23}Na) was also carried out to characterize the structure of these glasses as a function of rhenium content in order to check any effect of rhenium on glass formers.

Keywords: Glass structure, Rhenium incorporation, Borosilicate glass, Raman, NMR, XAS.

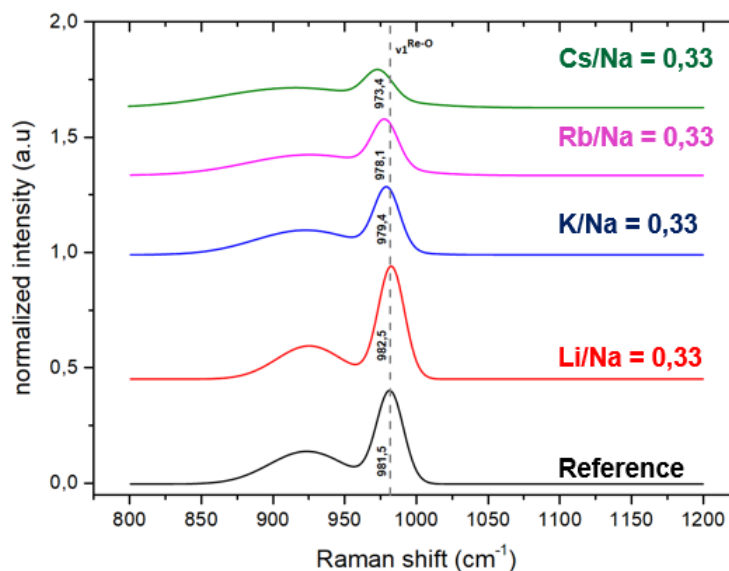


Figure 1 : Perrhenate $\nu_1^{\text{Re-O}}$ Raman shifts for five glasses differing in their alkali distribution (same targeted Re and overall alkali contents; the molar ratio of the two main alkalis is provided as a label for each spectrum). Plots are offset for sake of clarity

[Midorikawa et al., 2022] : Midorikawa, M., Gan, H., McKeown, D. A., Xie, X., Yano, T. and Pegg, I. L., Speciation and Solubility of Rhenium in Borosilicate Waste Glasses, *Journal of Non-Crystalline Solids*, vol. 580, p. 121219, March 2022. DOI: 10.1016/j.jnoncrsol.2021.121219