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The effect of polymorphic structure on the structural and chemical stability of yttrium disilicates

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Abstract

Under pressure and temperature conditions like those found in deep geological repositories (DGRs), rare-earth cations may react with silicates to form rare-earth disilicates. This study establishes the stability range of yttrium disilicates in response to changes in pH. The α, β, γ, and δ polymorphs of $Y_2Si_2O_7$ were synthesized by the sol-gel process at temperatures between 1100 and 1650 °C and subjected to pH_{stat} leaching tests. By measuring the Y and Si leaching rates and monitoring the transformation of the crystalline and amorphous phases, we showed that yttrium disilicates were stable at pH > 5. At pH < 5, the pH stability sequence was consistent with the temperature-dependent stabilities of $Y_2Si_2O_7$ phases, with the δ polymorph showing the lowest leaching rates. Because rare-earth compounds can be used as a proxy for analogous actinide hosts, the results of this study can be used to predict the performance of engineered barriers in DGR.

Keywords: Yttrium disilicates, sol-gel processes, polymorphism, leaching rate, nuclear applications