Raman Spectroscopic Studies of Hydrothermally Altered Borosilicate Nuclear Waste Glasses

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Raman spectroscopy is used to characterize structural changes that take place in a variety of hydrothermally altered borosilicate glasses used in durability studies for nuclear waste storage. The hydrothermal experiments (Vapor Hydration Tests (VHT)) were performed on glass wafers to investigate aspects of long-term alteration processes that may occur after disposal of the glass waste form.

Raman indicates two major glass structural changes during alteration: partial depolymerization of the alumino-borosilicate network, and incorporation of water or OH. Raman, as well as X-ray diffraction and scanning electron microscopy evidence, indicates analcime and other tectosilicate crystals at or near the altered sample surface with alteration layers containing intergrowths of amorphous silicate gels with zeolites and fine-grained clays.

Raman microscopy profiles and map images of VHT cross-sections show distributions of silicate phases within some altered layers, while other clay-like textured layers produce strong luminescence, over-whelming any Raman signal. Recent findings may indicate formation of spherical opal-like domains that may be sub-micron intergrowths of crystalline and amorphous phases. These phases and intergrowth textures may provide insights into alteration processes that take place to the glass structure at an atomic level.