

## Impact of increasing MoO<sub>3</sub> loading on incorporation properties of multi-component borosilicate glass

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Mo(VI)-rich residual material remaining after vitrification of high level liquid waste (HLLW) at the 'Karlsruhe Reprocessing Plant' (WAK) site can potentially be immobilized in borosilicate glass for ultimate disposal. Due to its low solubility in borosilicate glass melts, Mo(VI) tends to form molybdate-rich phases during the vitrification process. [1] These phases may crystallize during melt cooling and are able to incorporate radionuclides within their crystal structure. If water soluble alkali molybdates are formed, the release of radioactivity into the environment will be facilitated in case of water intrusion into a deep geological repository. The chemical composition of the formed phases is strongly dependent on the borosilicate glass composition used. Understanding factors favoring the formation of stable crystalline Mo(VI) phases in borosilicate glasses allows development of glass compositions capable of incorporating high Mo loadings, yet avoiding formation of soluble phases.

In this work nuclear waste simulate with varying MoO<sub>3</sub> concentrations vitrified in a multi-component borosilicate glass ([2]) was characterized. Powder X-ray diffraction and Raman spectroscopy studies confirm formation of crystalline CaMoO<sub>4</sub> and BaMoO<sub>4</sub> phases for MoO<sub>3</sub> concentrations above 4.5 wt%. Observed Mo K-edge high resolution X-ray absorption near edge structure (HR-XANES) spectral changes are correlated to different molybdate environments in the glass depending on the MoO<sub>3</sub> concentration. Fit analyses show that Na<sup>+</sup> cations preferably compensate molybdate charge over Ba<sup>2+</sup> and Ca<sup>2+</sup> at low concentrations. <sup>29</sup>Si nuclear magnetic resonance (MAS NMR) spectroscopic investigations show a strong impact of the different MoO<sub>3</sub> loadings on the degree of silicon network polymerization of the glass. No evidence for the formation of water soluble crystalline molybdates is found, indicating that the chemical composition of the glass used is favorable for immobilization of Mo-rich nuclear waste with this specific chemical composition.

[1] Lutze and Ewing (1988), *Radioactive Wasteforms for the Future*, North Holland, Amsterdam. [2] Grünewald *et al.* (2009), *Proceedings of Global 2009*, Paris.

## Correlative imaging of microbial transformations in Nature

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Correlative imaging is widely applied to obtain comprehensive information on the identity, activity and physiology of cells in eukaryotic cell biology. However, in the field of environmental microbiology this method is still little used despite its obvious potential. During the past years substantial progress was made at the MPI for Marine Microbiology (MPI-MM) to establish this method for our field. A particularly powerful approach used in our institute is the use of nano-scale Secondary Ion Mass Spectrometry (nanoSIMS) coupled to stable and radio-isotope labelling experiments to determine single-cell activity in the environment. By combining this approach with Fluorescence in situ Hybridization (FISH) we are able to link the identity of microbial cells in a complex microbial community to their in situ nutrient incorporation, which allows us to calculate cellular uptake rates and directly determine nutrient fluxes. The recent acquisitions of an Environmental Scanning Electron Microscope combined with an EDX system (ESEM/EDX) and a confocal laser Raman microscope coupled with an atomic force microscope provides further elemental, chemical-bond and structural information at a single cell level. I will present results of our correlative imaging studies of complex microbial communities in various marine environments.