Thermosublimatographic study of Te volatile species formed over LBE melts.

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Liquid metal cooled fast reactors (LFRs) are an important part of fourth-generation nuclear reactor technology. These reactors can "burn-down" long-lived actinides, significantly reducing the time required for spent fuel storage. To assess the safety of reactors of new designs, it is important to understand which radionuclides in the coolant can transfer into a gas phase, in which species, and what their vapor pressures are.

This work focuses on tellurium. Its isotopes are formed in the spallation zone of an accelerator-driven LFR system cooled with a lead-bismuth eutectic (LBE). Additionally, it is produced in fuel pellets as a fission product. Tellurium is also a polonium homologue, for which experiments are limited due to its radiotoxicity. These factors make tellurium an important element to study.

This work describes the thermosublimatography approach for studying the release of tellurium from lead-bismuth eutectic melts. The approach involves evaporating melt components and condensing them in a negative temperature gradient of a thermochromatographic tube. The different tellurium species condense at different temperatures, and their characterization is based on thermochemical parameters such as sublimation enthalpy and entropy (ΔH_{subl} and ΔS_{subl}). This allows the identification of volatile tellurium species that form in vapors over LBE melts using their corresponding deposition temperatures.

The study found that at 800 °C in a quartz glass tube the majority of tellurium evaporated in the form of lead telluride, which condensed at around 600 °C, followed by a tellurium peak at 300 °C, which likely corresponds to a ditellurium volatile form. A minor portion of tellurium evaporates in the form of bismuth telluride (T_{dep} = 500 ± 24 °C). An experiment carried out in a humid helium atmosphere demonstrated that the tellurium deposition site at 300 °C becomes predominant with a minor presence of bismuth telluride, while lead telluride was not observed.

Experiments performed in stainless steel columns did not show any deposition at 300 °C. In both dry and humid helium flows only the peak around 600 °C was observed. This may indicate that the formation of ditellurium species in quartz columns is due to surface interactions.

The deposition sites were additionally characterized using scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDX).

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