

High-Pressure Setup for Melting-Point Measurements of Refractory Nuclear Materials

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A new experimental setup is being developed at ITU for melting-point measurements on refractory nuclear materials at static pressures of up to 100 MPa. The goal is to limit the rate of sublimation and evaporation of materials with higher vapor pressures because the evolved vapor cloud may have adverse effects on the radiometric temperature measurement. Limiting the evaporation rate, as well as the experiment duration, is particularly important when investigating materials that tend to evaporate incongruently. This helps maintain the initial composition of the specimen. In addition, studying the pressure dependence of the melting point of nuclear fuels is relevant for their equation of state, as it provides important and rare data on the density of the liquid in the vicinity of melting. The technique is based on melting a specimen using a powerful continuous-wave Nd:YAG laser, typically in less than one second, and then reducing the laser power to allow the specimen to re-solidify while recording the thermogram. Interactions with the specimen holder are largely avoided by only melting a thin layer in the center of the specimen while keeping its periphery and rear side colder and solid (principle of the 'self-crucible' technique). The setup consists of a high-pressure vessel and associated gas-feed and compressor. Due to the radioactivity of the specimens, the high-pressure vessel must be enclosed in a glovebox, which is equipped with a suitable optical port. The vessel itself is fitted with a sapphire window. All opto-mechanical hardware is located outside the glovebox. The current status of the project will be reported, with a particular emphasis on the technical challenges and how they are being addressed.