

Design of an InGaAs-based Radiation Thermometer for POLARIS

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A new high-power laser facility (POLARIS) is being constructed at the Institute for Transuranium Elements for the out-of-pile simulation of the in-pile thermo-mechanical behavior of irradiated nuclear fuels. For measurements of the thermal diffusivity of the fuels a laser-flash technique will be applied. A new InGaAs-based radiation thermometer has been designed to measure both the steady-state sample temperature and the transient induced by the laser flash. The requirement to work in a shielded glove box using robotic manipulators, the fact that the sample will be placed in a vessel for moderately high pressures, and the presence of significant radial temperature gradients on the sample outside a central spot of roughly 2 mm in diameter, severely limit the throughput of the radiometer. Several configurations were explored in order to satisfy as best as possible the desired specifications of a noise-equivalent-temperature-difference of 100 mK at a true temperature of 1000 K and a temporal resolution of better than 100 μ s. A model was implemented to predict the signal and the S/N ratio as a function of temperature in each case, taking into account realistic values for the properties of commercially available windows, lenses, filters, detectors, and transimpedance amplifiers. Based on these calculations suitable components were chosen and an instrument was built. This model-based design approach, as well as first test results are presented.