High Temperature Emittance Studies of Generation IV Nuclear Materials by Laser Heating and Multi-Channel Radiation Thermometry

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Potential nuclear plants of the new generation (Generation IV) are likely to employ a series of original materials both as fuel, cladding/coating, and as structural materials. The high temperature properties of such materials are often little known. Laser heating and fast radiation thermometry techniques are used at the European Commission's Institute for Transuranium Elements (ITU) of Karlsruhe (Germany), in order to study thermodynamic and thermophysical properties of nuclear materials at high temperatures. High-temperature emittance, in particular, is a fundamental parameter for the comprehension of the thermal behaviour of a material under extreme conditions, such as those that can be produced, for instance, in a nuclear reactor in case of malfunctioning. In this framework, a multi-channel radiation thermometry method is described here, for measurements of the normal spectral emittance at visible and near-infrared wavelengths of solid and liquid samples. It combines the use of a 256-channel spectrometer with a least-squares regression algorithm that is based on a parametric formulation of Planck's law. The spectrometer's temporal resolution of about 1 ms allows for fast measurements. This is an essential feature when samples are to be investigated in a temperature range (T>2000 K) in which the kinetics of vaporisation and reaction between sample and crucible are particularly rapid. Results on solid and liquid carbides of various compositions of interest for Generation IV nuclear plants are presented.