ABSTRACT

Modern technology demands high temperature and high performance materials such as advanced ceramics, composites and other refractory substances for a variety of applications. These materials often get exposed to very high temperatures (>2500 K). In order to understand the behaviour of these refractory materials at very high temperatures, it is necessary to establish their thermophysical properties such as vaporisation rate and stability at such elevated temperatures. These properties are especially required to analyse the behaviour of nuclear reactor fuels under accident conditions.

Off-normal events in liquid metal cooled fast breeder reactors (LMFBRs) can result in the release of a large amount of energy. Such events have the potential of taking the reactor fuel or a portion of it to very high temperatures (up to 5000 K) and can lead to partial or complete disassembly of the core. The analysis of this type of accident requires the knowledge of the equation of state (EOS) of the reactor fuel at high temperatures. The energy release in such accidents depends strongly on how quickly the vapour pressure develops. Hence the knowledge of equation of state of the fuel material becomes essential.

Theoretical approaches based on the principle of corresponding states (PCS) and extrapolation methods are used in this study to generate the EOS of nuclear fuel materials.

Conventional experimental techniques which are used for the measurement of thermophysical properties of refractory materials below 2500 K cannot be used at ultra high temperatures (>3000 K) because of obvious limitations such as: non-availability of inert container material at such elevated temperatures, difficulty in attaining, controlling and sustaining such high temperatures, difficulty in the measurement of physical and chemical properties under these conditions.
Hence we have built-up a laser-induced vaporisation mass spectrometry (LIV-MS) facility to generate EOS of reactor fuel materials and studied the vaporisation behaviour of UO₂. Results obtained on laser vaporisation of SiC and HfO₂ are also reported.

While developing our LIV-MS facility, care was taken to make it versatile enough to use for many other applications. Some possible applications such as cluster studies, thin film coating, Matrix Assisted Laser Desorption are also indicated.