Recent Progress Addressing Compatibility Issues Relevant to Fusion Environments

B. A. Pint,[1] J. R. DiStefano,[1] P. F. Tortorelli[1] and A. Jankowski[2]

[1]*Oak Ridge National Laboratory, Oak Ridge, TN 37831-6156, pintba@ornl.gov*
[2] *Lawrence Livermore National Laboratory, Livermore, CA 94551, jankowski1@llnl.gov*

There are numerous potential compatibility issues in fusion reactors. Specific concerns are determined by reactor concept, including the cooling and tritium breeding schemes. This paper addresses research aimed at understanding critical scientific and technological factors associated with several key areas of current interest.

The greatest effort is devoted to examining the compatibility of ceramic materials with molten Li. Electrically insulating coatings are needed on the first wall of magnetic confinement reactors to reduce the pressure drop due to the magneto-hydrodynamic (MHD) force on the flowing Li. Very few candidates are sufficiently compatible with Li at high temperatures (600-800°C), but the most promising candidates are AlN, Y_2O_3 and Er_2O_3. Coatings of Y_2O_3 have been marginally successful in static Li capsule tests and Er_2O_3 coatings are currently being investigated. Cracks cannot be tolerated in this coating because Li will likely wet the crack surfaces. Therefore, an outer vanadium layer will likely be required . This outer layer also may significantly inhibit the solid state reaction between the ceramic coating and Li. In-situ experiments are being developed to test this dual-layer concept.

While SiC composites are being widely investigated because of their high temperature strength, limited information is available about its compatibility with Pb-Li at temperatures of 800°C and higher. As a first step in assessing the maximum operating temperature for this concept, specimens of dense, high purity monolithic SiC were exposed to Pb-17at.%Li for 1000h in isothermal capsule tests at 800° and 1100°C. After 1000h at 800°C, no evidence of reaction or wetting between SiC and Pb-17Li was observed. No specimen mass change was observed after 1000h at 1100°C, but there was evidence of limited wetting. These results suggest that SiC is compatible with Pb-17Li to at least 1100°C in a static environment.

Finally, some work on the oxygen uptake kinetics in vanadium alloys and the effect on mechanical properties continues. Prior work in low oxygen pressures found linear kinetics at the lowest pressures relevant to a high purity fusion environment and an appropriate model was developed. The current effort is examining kinetics at 700°C in high purity He environments to determine the effect of system pressure and impurity content.

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