Beryllium Coatings on Inconel Tiles

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Beryllium will be the plasma-facing material on the main chamber wall of JET (Joint European Torus) during the ILW (ITER like wall) project. The material foreseen for the main chamber wall is bulk Be at the limiters [1] and Be coatings on Inconel tiles at the recessed areas. Inconel tiles will be coated with an 8–9 μm Be thick film deposited by thermal evaporation performed in the Nuclear Fuel Factory, Pitesti, Romania [2-3].

Deposition of Be on Inconel_625 substrates was performed in a stainless steel vacuum chamber (evacuated by a diffusion pump and reached at a base pressure of 5 x 10^{-6} mbar) which is 0.4 m^3 in volume. Prior to deposition the surface of the Inconel_625 samples was sandblasted using alumina powder of 45±5 μm in diameter.

The Inconel_625 samples were positioned at about 400 mm distance from the crucible on a rotating cupola-shape holder, 600 mm in diameter. Together with inconel samples, were coated zirconium alloy samples (3 x 4 x 25 mm^3) as witness sample to monitor the coating thickness. Thermal evaporation of beryllium (1287°C melting point) was performed using a sintered beryllium oxide crucible (BeO – beryllia – 2530°C melting point), heated by a molybdenum resistor. The temperature of the beryllia crucible was measured by a pyrometer. The beryllia crucible was filled out with 7 g of pure beryllium (pebble), heated at about 1500°C until all Be was evaporated. The substrate temperature during process was starting from RT and reached at 150-200 °C during 2 hours process.

After evaporation and cooling down of the system, the witness samples were tested by simple scratch test, a puling test and a nondestructive backscattering test for thickness evaluation. Thickness, measured by a beta-backscattering apparatus (Microderm of UPA TECHNOLOGIES, USA), calibrated by measuring with a stylus profilometer the steps produced on the deposited films, was found of 7 ±0.5 μm when 7 g of Be were used for evaporation. When 9 g of Be were used, a thickness of about 9 μm was found, suggesting a linear dependence of thickness with the Be evaporated quantity in this range. The tests carried out on inconel test pieces pf 20 mm x 40 mm x 3 mm in the JUDITH facility proved that the layers survived undamaged at power loads of up to 2.6 MW m^{-2} in 6.2 s (deposited energy density of 18.1 MJ m^{-2}) thus significantly exceeding the required level of 5 MJ m^{-2}. This qualifies the evaporation process to be used for coating of large areas of the JET vessel inner wall.

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