DEVELOPMENT AND TESTING OF 140 GHZ ABSORBER COATINGS FOR THE WATER BAFFLE OF W7-X CRYOPUMPS

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Due to the relatively high strayfield radiation (140 GHz) from the electron cyclotron radio frequency heating system to which the W7-X cryopumps are expected to be subjected, coating systems acting as an efficient absorber for 140 GHz radiation have been developed for the water-cooled baffle shield in order to reduce the thermal load on the liquid N shield and the liquid He cryopanel.

Several types of oxide ceramic coatings were applied on planar copper substrates by Atmospheric Plasma Spraying. Different ceramic powders in composition and grain size were used as feedstock material for the coating operations. The influence of the process parameters on the coating properties and microwave absorbing capability at a frequency of 140 GHz was analyzed. The coatings microstructure and mechanical properties were characterized in terms of porosity, microhardness, roughness, adhesion and residual stress distribution. XRD and SEM of the layers were carried out. Thermal cycling and outgasing tests were performed on the samples. It was found that film thickness and microstructure of the sprayed coatings have a significant influence on microwave absorption behaviour. For Al_2O_3/TiO_2 coatings, absorption values over 90% were obtained over a broader range of incidence angles for the 140 GHz probing beam.

After optimization of the coating structure for maximum microwave absorption, the coating procedure had to be adapted to the complex water baffle geometry. Therefore a special torch kinematics had to be developed to ensure a nearly complete and even covering of the chevrons surface. This development was performed on a mock-up with demountable chevrons. With this aim, two of the optimised Al_2O_3/TiO_2 coating systems with different TiO_2 content (13% and 50%) were applied.

The selected spraying parameters and kinematics were then used for the complete coating of four mock ups, which have been tested in the W-7X strayfield test facility Mistral. Two mock ups were coated with Al_2O_3/TiO_2 87/13% and two with 50/50%. These were tested together with an uncoated and a blackened mock up (as benchmark component).