Material, Radio-Frequency and Mechanical Characterisations of High Current Steady-State Sliding Contacts for the ITER ICRH Antenna

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Topic: ITER-related research and Development issues

The ITER Ion Cyclotron Resonance Heating (ICRH) system is designed to couple 20 MW (10 MW each from two antennas) of RF power in the 40-55 MHz frequency range during 3600 s and under various plasma conditions with Edge Localized Modes. Radio-Frequency (RF) contacts are integrated within the ITER ICRH launcher in order to ensure the RF current continuity and ease the mechanical assembly. The contacts allow the free thermal expansion of the Remote Vacuum Transmission Line coaxial conductors during RF operations (peak RF current up to 2.5 kA per line at 55 MHz in steady-state conditions in the ITER vacuum environment) or 250°C baking phases. The reliability of the ICRH launcher is directly linked to these contacts, which have to withstand 30000 cycles without any routine maintenance. For this reason, the qualification of the contact materials and design requires extensive characterisations. A material and tribological experimental campaign has been carried out to determine which materials and associated coatings are relevant for RF contacts application in ITER. Following this selection, different base material samples and coating combinations have been procured and analysed (coating quality and wear resistivity). These samples have been tested in a dedicated high temperature vacuum tribometer, in which both the electrical contact resistance and the friction coefficients have been measured in vacuum and temperature environment. In parallel, RF tests have been performed with a new prototype of Multi-Contact® LA-CUT/0,25/0 contacts made of silver-coated CuCrZr louvers. During these tests, currents between 1.2 kA and 1.3 kA have been reached a few tens of time in steady-state conditions (duration longer than 60 s) without any visible damage on the louvers. Several shots have been performed at currents between 1.4 kA to 1.6 kA and during 1200 s. The RF current has been increased on the RF contacts up to a maximum of 1.9 kA during 300 s at 62 MHz, current at which the contacts suffered irremediable damage. In addition, a test bed which performs sliding test cycles has been built in order to reproduce the wear of the contact prototype after 30 000 sliding cycles on a 3 mm stroke at 175°C under vacuum. The silver coating of the louvers is removed after approximately a hundred cycles whilst, to the contrary, damage to the CuCrZr louvers is relatively low. The test beds developed during this work and the data collected gives confidence in the realization of optimized contacts for ITER.