MECHANICAL DESIGN ANALYSIS OF ITER-RELEVANT LHCD ANTENNA ELEMENTS

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A 20 MW Lower Hybrid Current Drive system using an antenna based on the Passive Active Multijunction (PAM) concept is envisaged on ITER for steady state operation, including the current ramp-up phase. In the frame of an EFDA task, a conceptual design of such a system has been performed. This paper gives an insight of the mechanical analysis, modeling and design carried out on two elements of the antenna: the front face, and the RF windows which constitute the first tritium barrier.

The front face of the antenna will have to withstand high heat and fast neutrons fluxes directly from the plasma. It will be actively cooled and present a beryllium coating upon ITER requirement. The main issues were to ensure a reasonable margin versus a maximum temperature fixed by safety concerns (650 °C for plasma facing beryllium), and to understand and assess resistance of the assembly while in operation. Analyses were conducted on some variants of this PAM. Manufacturing scenarios considering ITER requirements and involving various techniques (brazing, high isostatic pressure bonding, explosion bonding) were explored, and simulations over subsequent residual stresses were conducted. Analyses showed that surface temperatures do not exceed 500°C, and stresses should not affect the integrity of the antenna mouth.

The RF window is a critical component since it also has a safety function. We planed to design a water cooled 5 GHz CW RF “pillbox” window capable of sustaining 500 kW of transmitted power. An RF optimization conducted on this concept allowed to combine good RF properties and low dielectric losses. It resulted in a maximum thermal stress in the ceramic of 31 MPa, well below the static fatigue limit of 50 MPa. The residual stresses resulting from the brazing methods involved in the manufacturing of this multi-material assembly (copper, copper alloys and ceramic) were also analyzed.

Both studies allow us to move forward and focus on critical issues, such as manufacturing processes (beryllium, bonding techniques…) and R&D associated programs including test of mock-ups.