Materials and manufacturing aspects of the structural components for the ITER ECH Upper Launcher

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The EC wave launching system at the upper port level of ITER is developed under EFDA by the “ECHULA group” of EU associations (ENEA/CNR Milano, CRPP Lausanne, FOM Rijnhuizen, FZK Karlsruhe, IPP/IPF Garching/Stuttgart) for inducing localised current drive (CD) with the current reference design of 4 “Extended Performance front steering Launchers” covering a plasma locations ρ_p of 0.4 - 0.9.

The first wall to the plasma is formed by blanket modules that are mounted in front of the vacuum vessel. These regular blanket components define the basic material concept (multicomponent structure of Be, Cu and stainless steel) for the first wall panel (FWP). The Be liner which requires special handling precautions has to withstand radiation loads up to 50 W/cm² and volumetric heat loads of up to 3 W/cm³. The radiative and neutronic loads decay very fast with increasing distance from the plasma, and thus active cooling is indispensable up to the first 100 cm behind the FWP. Thus the blanket shield module and the front part of the main frame are to be equipped with very efficient cooling systems. The structural parts of these components are formed by stainless steel (AISI 316 L(N)-IG).

Guided by this material choice, double wall structures are under development to respond to the special cooling request. In this concept, ribs between the inner and outer wall form meandering cooling channels, fed by water of 100°C at a pressure of 3 MPa. As both the inner and outer wall parts face the high-vacuum given for in-vessel components, the manufacturing has to ensure an optimum performance component with respect to leak tightness, mechanical robustness and high geometrical precision. These challenges combined with the complex geometry the BSM housing can only be met with advanced manufacturing routes. Together with institutional and industrial partners, alternative techniques are under development of which the most advanced one is hot isostatic pressing (HIP). Alternative manufacturing approaches are considered in which the outer and inner wall structure are brazed. The strengths and draw-backs of either approach are discussed in order to evaluate the suitability as a reference manufacturing route for double wall structures. This study includes microstructural analysis and strength assessment of the joining interfaces between ribs and walls.

Proposals for continued collaborations:
JAEA (K. Sakamoto, K. Takahashi) on design and analysis of the structural components of ECH Launchers at ITER (equatorial and upper port plugs), handling and thermal tests of shielding elements, and on high power torus windows.

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