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Target technologies R&D for EU-DEMO divertor

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Within the roadmap of the EU-DEMO reactor design, the divertor design is being developed in the framework of the EUROfusion Consortium Work package "Divertor", sub-project DEMO (WPDIV-DEMO).
The ultimate objective of this sub-project is to deliver at least one holistic design concept and feasible technology options for the DEMO divertor and limiter eligible for the subsequent Engineering Design Activities (EDA) phase.
For the divertor targets, the qualified design and technology is that of ITER: monoblocks in W equipped with a copper interlayer of 1 mm thickness, obtained by casting or HIPing, welded by diffusion bonding or by brazing on a CuCrZr pipe. In parallel, for risk mitigation, dedicated R&D shall be conducted for alternative technologies with the aim of increasing the resistance of the components to damage due to neutron radiation.
Due to the high thermal gradients that are generated in the target (less than 10 mm elapse from 2000 ° C of the surface to the cooling water temperature), the heat sink material must have high mechanical strength and high conductivity. So, the CuCrZr is the best candidate. However, in addition to not being a low-activation material, which makes it unattractive for its use in fusion plants for the commercial production of energy, it undergoes a high degradation of its mechanical characteristics under the neutron radiation provided in DEMO. To limit the damage the CuCrZr should be kept at a temperature higher than 200 ° C, but not higher than 350. The narrow operating window is making the thermo-hydraulic design of the DEMO divertor complicated.
In particular, the R&D activities are aimed at the production of components with cooling composite pipe in W fiber and copper matrix. The W, present in a high percentage in these tubes, ensures mechanical strength, high conductivity, low neutron damage and less activation. Some promising results were obtained in the final phase of Eurofusion Horizon 2020, and up-scaling to larger components is the main object of the work in recent years.
In addition to the manufacturing of the pipes, it is necessary to develop and verify a reliable joining technology with W monoblocks. Joining techniques by brazing and by copper casting are being studied and tested. This work reports on attempts and results, not always encouraging, achieved.

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