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Progress of Fusion Technology at SWIP toward Reactor

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China has made its fusion energy development strategies with a route from ITER over through a test reactor towards the future DEMO reactor. As one of the institute for fusion energy development in China, SWIP is focusing on investigation of plasma physics and magnetically confined nuclear fusion by operation the HL-2A Tokamak. In addition, SWIP has been being engaged in the development of fusion technologies in recent 10 years, majoring in fusion reactor materials, tritium breeding blanket and divertor by joining the ITER programme and the domestic fusion energy development projects. SWIP is leading R&Ds on the ITER TBM in China and has developed the technologies for ITER first wall, shielding blanket modules, magnet support and so on through a number of ITER procurement arrangements. Two research centers were established in SWIP for developing the technologies for blanket and divertor for fusion rectors. A lot of facilities have been built and put into use for manufacturing and testing the ITER in-vessel components, developing advanced materials and the material joining technologies, such as the 1400℃/200 MPa hot iso-static pressing machine for thermal diffusion bonding plasma facing armor materials to heat sink or steel structures, the 400kW EB facility for high heat flux test of FW and divertor component, a 8 MPa/300-500℃ Helium testing loop for studying the hydraulic performance of the Chinese HCCB TBM. CLF-1 RAFM steels in 5 tons scale has been made with acceptable physical and mechanical properties for ITER TBM. Small scale TBM mock-ups have been manufactured along with extensive investigation of welding technologies, including TIG welding, Laser and EB welding, HIP bonding, etc. Production of Be pebbles as neutron multiplier and Li₄SiO₄ tritium breeder have been demonstrated in laboratory and are scaled up to 10 kg scale for future application. Beryllides are made in laboratory as promising candidates for advanced neutron multipliers. The bonding of Be and W tiles to CuCrZr alloy heat sink has been successfully performed by HIP joining and brazing to develop the FW and divertor technologies. Be/CuCrZr Mock-ups and an EHF FW semi-prototype were made, which are tolerable for 4.7 MW/m² for the ITER designed number of cycles. W/CuCrZr divertor mock-ups survived successfully from 10 MW/m² power density for 1000 cycles and 15 MW/m² for 300 cycles. Recently the technologies for a small unit of advanced helium cooled divertor were developed, for which a couple of W-Y₂O₃ and alloys were made with expanding application temperature window. A 1-10 eV (10²²~10²³/m²/s in flux) linear plasma device is under construction for plasma-material interaction studies with the synergistic effects of “plasma-heat-displacement damage”on PFMs. For better high-temperature performance, alternative structural materials such as ODS RAFM steel and carbide dispersion strengthened (CDS) vanadium alloys have been studied. This paper will show the status and highlight the progress in past years in SWIP for the fusion technologies for ITER and the reactor beyond in China.

Eligible for student paper award?

No

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