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Overview of Fusion Reactor Materials Study at SWIP

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Development of materials is an important issue for the future nuclear fusion reactors. In this paper, the developments and main achievements of fusion reactor materials at Southwestern Institute of Physics (SWIP) are overviewed by focusing on the plasma facing materials/components (PFMs/PFCs), structural materials and functional materials. For PFMs/PFCs, an ITER grade high purity tungsten and the CVD-W coating with a fast deposition rate up to 0.5 mm/h have been developed and characterized. High heat flux components fabricated by joining them with CuCrZr alloy have been developed, which can provide a simple and economics method for the construction of W first wall and divertor in the current fusion devices. For structural materials, two kinds of low activation materials are developed, one is a reduced activation ferritic/martensitic (RAFM) steel, named as CLF-1, aiming at the near team use, such as ITER-TBM and CFETR. The other one is V-4Cr-4Ti alloy, aiming at future applications in the next generation fusion reactors. Compared with other RAFM steels, such as Eurofer 97 or F82H, CLF-1 has similar chemical compositions, but N is selected as a controllable element and has slightly higher content, which induces higher tensile strength, in particular better high-temperature creep performances. As to vanadium alloys, an engineering scale ingot of V-4Cr-4Ti alloy with 30 kgs has been prepared by melting, and mechanical alloying has been used for dispersion strengthening with different particles, such as Y2O3, TiC, SiC and Ti3SiC2. Preliminary results indicate the newly designed multi-component alloy V-4Cr-4Ti-1.5Y-0.3Ti3SiC2 has the most efficient strengthening effect and the best thermal stability. In the case of functional materials, tritium breeder and neutron multiplier materials are developed for the fabrication of ITER-Chinese Helium Cooled Ceramic Breeder Test Blanket Module (CN HCCB TBM), and the potential application in CFETR. Moreover, some of the specialized facilities have been constructed at SWIP, a comprehensive capability for development, evaluation and testing of materials/components is being established.

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Author: Mr LIU, Xiang (China)

Co-author: Mr CHEN, Jiming (Southwestern Institute of Physics)

Presenter: Mr LIU, Xiang (China)

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