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STRUCTURAL MATERIALS DEVELOPMENT AND DATA BASES

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Fusion will most likely be deployed in the second half of the 21st century as a low carbon emitting energy source to sustain the electricity base load. The fusion plants will have a large scale, to extract the deuterium tritium heat economically from the plasma. Such type power plant needs a high availability and reliability to fulfil its primary function. The development of structural materials is one of the main keys to the success of the fusion power plant operation, and its predecessor DEMO. The materials total life cycle controls the choices of crucial components such as blankets and divertors to a high degree. For example the low activation needed during operation and re-cycling stage affects the selection of source materials. The first generation of blankets will most probably be built from reduced activation steels, which are presently in a most advanced stage for application. Simulations for the EU reference steel so far are limited to the use of mixed and fast spectrum fission reactors up to levels of 80 dpa. Such fission simulations miss the effects of transmutation products generated at high rates such as helium and hydrogen that affect the properties strongly. The databases for the steels presently accumulated are valuable first estimates of their potential for application in DEMO. Before entering the final design materials testing in a 14 MeV neutron source simulating the near plasma environment is essential. The International Fusion Material Irradiation Facility, IFMIF, will provide a more realistic simulation of the damaging “burning” plasma environment. The design of IFMIF itself will rely on the databases generated with results obtained in fission reactors.
In the race for higher efficiencies of blankets a stepwise approach will lead to application of oxide dispersion strengthened steels, with a nano-microstructure, which are in an early stage of development. The application of silicon carbide ceramic composite might break through, first as liner in steel blankets, later as complete structure. Before full utilisation of silicon carbide many hurdles have to be overcome. The development of divertors will depend on the use of refractory metals for high heat flux surfaces allowing higher coolant temperatures and different coolants. The high temperature embrittlement of tungsten is an obstacle that is presently attacked with promising special thermo-mechanical treatments on a laboratory scale.