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Status of the Flow Channel Insert Development for the US-ITER DCLL TBM

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The US-ITER DCLL (Dual Coolant Liquid Lead) TBM (Test Blanket Module) is being designed with a SiC-based Flow Channel Insert (FCI). The FCI serves to thermally and electrically isolate the Reduced Activation Ferritic/Martensitic Steel (e.g. F82H) structural material from the high temperature PbLi coolant. The primary load on these FCIs will come from thermal stress. The temperature drop across the FCI is between 50 and 70\textdegree{}C for ITER, while the temperature gradient expected for DEMO is \textasciitilde{}200\textdegree{}C. The US fusion technology and materials programs are developing a number of FCI concepts, based on SiC/SiC composites and porous SiC foam sandwiched between CVD-SiC facesheets. Such FCIs are considered for testing in ITER as part of the Test Blanket Module program. For ITER testing, it is considered to limit the outlet temperature of the US DCLL test blanket module to \textasciitilde{}500\textdegree{}C to ensure material compatibility, which may limit temperature drops across the FCI to \textasciitilde{}100\textdegree{}C.

In this paper, we detail the most recent development status of the FCI concepts. Sample FCI structures are discussed and relevant thermo-mechanical analyses and property measurements are presented. The impact of neutron-induced differential swelling due to temperature differences across the FCI have also been modeled and the impact of radiation-induced creep relaxation has been considered. Performance of the FCI concepts are being evaluated based on maintaining electrical and thermal insulation between the structure and the PbLi coolant.

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