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Expermental and numerical investigation on anti-fatigue and anti-thermal shock performance of the divertor first wall

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After years of exploration and development, research of magnetic confinement nuclear fusion is progressed into stage of experimental fusion reactor construction and test. As a key plasma-facing component, the anti-fatigue performance of first wall of fusion reactor receives widely concerns. Due to the fact of enduring both periodic loads of pulse operating mode and shock loads of transient events such as disruption, ELMs etc, the coupled fatigue responses of material and structure are in the state of very complex. It is significant and necessary to research the coupled mechanism of fatigue by both transient and periodic heat loads, which will be beneficial to develop the key and new technology of promoting anti-fatigue performance for the first wall of fusion reactors. With such motivations, a multi-purpose experimental platform integrated both high heat flux loading and heat shock loading as well as mechanical force loading is established. And meanwhile, a relative complete finite element analysis method based on a full coupled thermal/structural heat transfer equation with consideration of elastic/plastic constitutive relation as well as multiple kinds of thermal physical effects such as melting, solidification, evaporation etc. is established. Based both experimental and numerical works, the thermal/mechanical response of first wall and its fatigue performance are investigated. It is concluded that the fatigue life time of first wall is decreasing nonlinearly with increase of heat loads magnitude， and the coupled periodic normal loads and shock loads induced by transient events will greatly reduce the fatigue life time of first wall. And serverial techniques to improve anti-fatigue and anti-thermal shock performance are explored with both experiments and numerical tests.

Eligible for student paper award?

No

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