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相変化熱輸送システムを導入したダイバータにおける非定常熱負荷による熱応答特性

Thermal response of divertor with phase transition heat transport system in dynamic heat load

権　暁星[1], 笠田　竜太[2], 小西　哲之[2]
H.S. Gwon[1], R. Kasada[2], S. Konishi[2]

[1]Graduate School of Energy Science, Kyoto University
[2]Institute of Advanced Energy, Kyoto University

The target surface of divertor is subject to high heat flux and energy particle from plasma. In case of ITER, the heat flux is postulated to be average of 10MW/m², peak of 20MW/m². However, peak 100MW/m² order at a few milliseconds intervals by ELMs, and in case of DEMO divertor load onto the surface cannot be expected to be significantly reduced. This study reports the thermal response by ELMs at target of divertor investigated by finite element analysis. This study considered 2 kinds of divertor model. Model-1 was mono-block, and Model-2 was our new concept of divertor that phase transition of liquid metal was applied in heat transport system to remove localized load. Pulsed 10~100MW/m² ELMs were considered to be applied to the target surface of each divertor model, and duty, pulse width of ELMs, and thickness of tungsten armor were considered as parameters. Transient temperature profile, temperature gradient and thermal stress of each divertor model were evaluated by ANSYS. Fig 1 shows an example of temperature on the target surface with single pulse (100MW/m²-10ms) in Model-2. It exceeded recrystallization temperature of tungsten, and thermal stress was 423MPa on target surface. Design windows of the divertor target were identified for two models, and compared. When heat flux with 10% duty, 100ms pulse width was applied target surface, in case of Model-1, applied heat flux was limited to 6MW/m² to prevent recrystallization of tungsten. However, in case of Model-2, the limit was 20MW/m², and it was 4 times larger than that of Model-1.

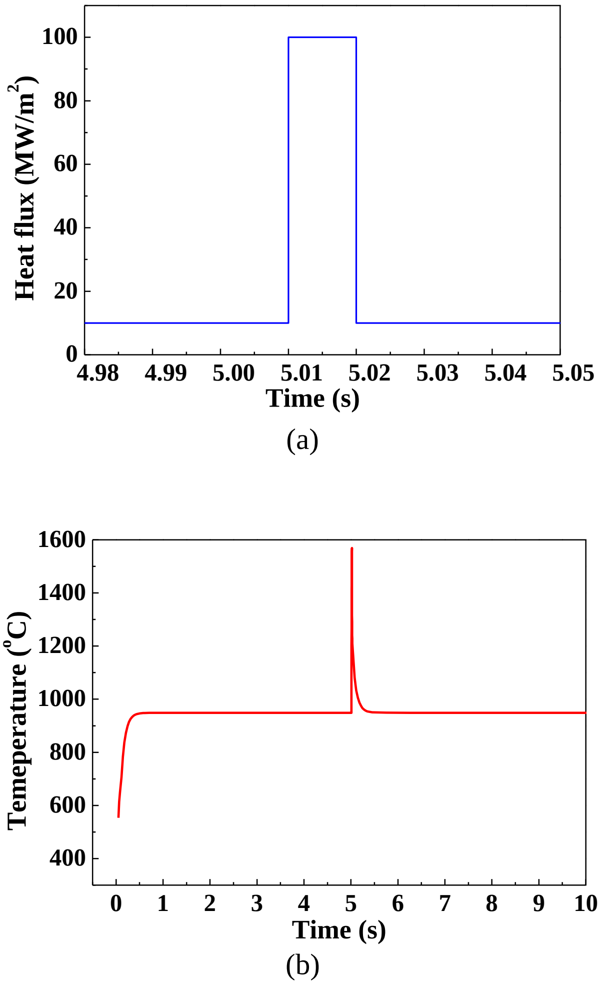

Fig. 1 Temperature of target surface with single pulse (100MW/m²-10ms) in Model-2
(a) Input single pulse, (b) Temperature of target surface