## §20. Evaluation of Cooling Performance and Material Damage of a Divertor due to High Heat Flux

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An aim of this study was a development of a divertor with an excellent integrity. Surface damages, steady state cooling performances and a burnout heat flux were measured and evaluated since a divertor plate of the LHD is exposed to local high heat fluxes. In particular, fatigue life limits due to thermal shocks were evaluated. The burnout heat flux was evaluated, and changes in surface structures and mechanical properties of plasma facing materials due to thermal shock fatigue were also evaluated. A relationship between the mechanical properties and the burnout heat flux was studied, and these results will be useful to evaluate the life limit of the divertor plate.

A deflection-type electron beam heating apparatus with a 15kV-2A maximum power, by which cyclic and short pulse heatings were possible, was designed and manufactured for thermal shock fatigue tests. Fig.1 shows the deflection-type electron beam heating apparatus. A mock-up of plasma facing components with a cooling structure was manufactured and the apparatus carried out cyclic high heat load tests. The burnout heat flux will be evaluated quantitatively for various cooling structures and conditions. Changes in properties of joining layers were measured and the integrity of joining parts of the divertor mock-up was confirmed.

Fig.2 shows the divertor mock-up. The cyclic tests to 1000 cycles by 10 MW/m$^2$ and 12 MW/m$^2$ heat loads confirmed the integrity of the mock-up. A surface temperature of a C/C composite material and the temperatures of upper and lower parts of the joining boundary of the mock-up were measured. Fig.3 shows the relationship between the temperatures mentioned above and the shot number of a cyclic heat load of 10 MW/m$^2$.

It is necessary to select an adequate material and a structural design for the divertor in steady state operations of the LHD. Some mock-ups with joining parts were manufactured and cyclic heat load tests were carried out. After the tests, thermal and mechanical properties were measured. The results will contribute to the design and the evaluation of the life limit of the divertor plate for the LHD.

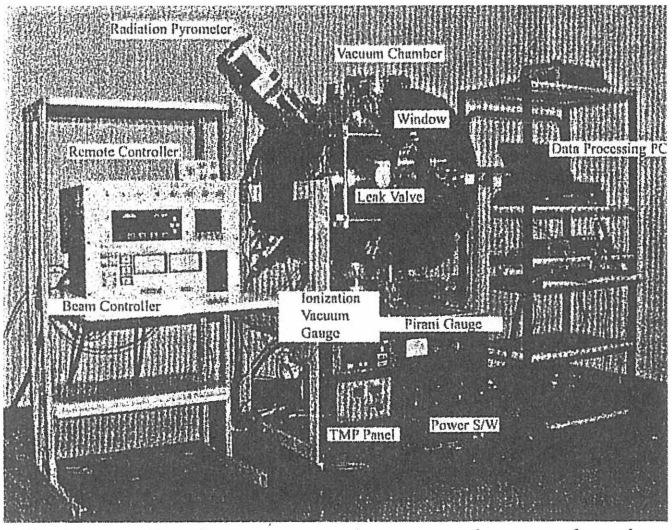


Fig.1 Deflection-type electron beam heating apparatus.

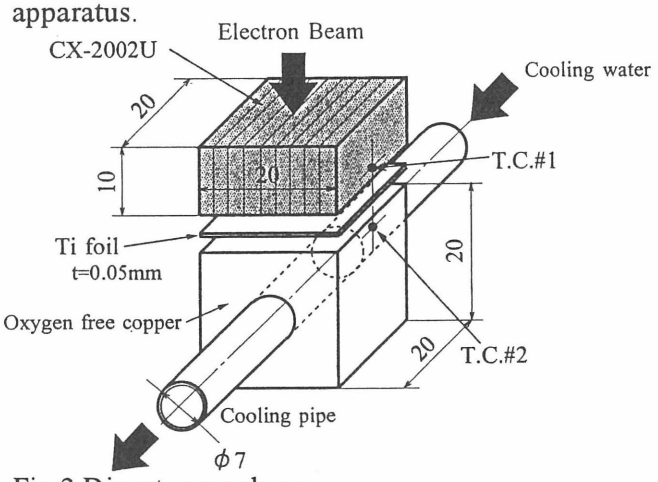


Fig.2 Divertor mock-up.

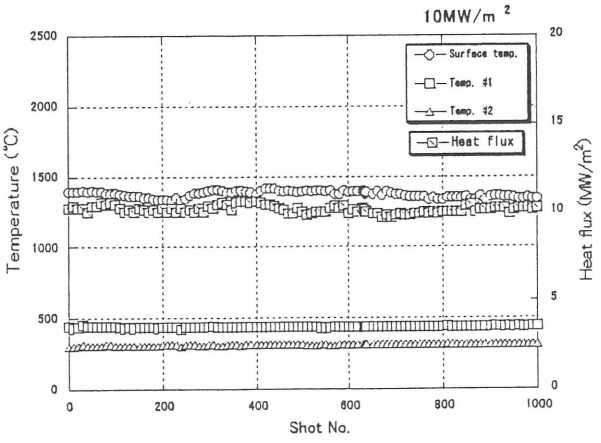


Fig.3 Relationship between the temperatures of a mock-up and the shot number of a cyclic heat load of 10 MW/m$^2$.