Measurement of divertor heat flux in helical-axis Heliotron-J device using a thermal probe

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It is well known that there exist the sheath regions between plasmas and solid components which face to plasmas and that current through these sheath is determined by the sheath potential drop. According to sheath theory, momentum and heat flux through the sheath is also the function of the sheath potential drop. Recently Combined force-Mach- Langmuir probe[1] and thermal probe[2-3] were proposed to measure these flux and to obtain not only electron parameters but also ion information such as its temperature.
It is also very important to measure the heat flux itself in divertor plasma. In the design of fusion reactors like International Tokamak Experimental Reactor(ITER), vast heat flux($> 10[\mathrm{MW/m^2}]$) is expected to flow onto divertor target plate through this sheath boundary. In order to check proposed methods to reduce this heat load such as "detached plasma formation", direct measurement of heat flux is indispensable, since relation between heat flux and plasma parameter is very complicated and ion temperature is sometimes larger than electron temperature in divertor plasma.
Basic concept of thermal probe is very simple. From the probe tip temperature (T_p) data, heat flux to probe surface Q can be deduced by solving heat conduction problem. For DC discharge plasma, we can use the simple steady relation such that $Q \sim \Delta T_p$. Last year thermal probes and directional Langmuir probes used in Compact Helical system[4] were moved to Heliotron-J device[5] under Collaboration with NIFS. However, heat flux calibration of these thermal probes has not yet completed, mainly since discharge pulse length is shorter than thermal diffusion time in a probe tip and steady state heat conduction model is not available.
In this paper, two unsteady heat conduction model are constructed and heat flux is estimate from experimental data of type-K thermo couples in thermal probe. By using the second improved model, we will also discuss the possibility to decrease time response delay and detect heat flux change in L-H transition.

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