TST-2における小型ロゴスキーコイルを用いた局所電流計測の開発

Development of a local plasma diagnostic using small Rogowski coil in the TST-2 spherical tokamak

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Local plasma current diagnostic using a small Rogowski coil has been developed in the TST-2 spherical tokamak device ($R = 0.38$ m, $a = 0.25$ m, $B_t = 0.3$ T, $I_p = 0.1$ MA). On TST-2, current drive experiments using lower hybrid wave have been performed. In these experiments, obtaining current density profile is crucial to understand and optimize the current drive method, and practical local current diagnostics are required. A Rogowski coil is such an attractive tool, because it can detect current signal without any assumptions and very cost effective tool.

In this study, a new Rogowski coil is developed (see Fig.1). When we apply the method to a tokamak plasma, the Rogowski coil should be designed small to minimize the perturbation to the plasma. In addition, the sensitivity to toroidal and poloidal magnetic fields (B_t and B_p) should be as small as possible, while it should have large turn numbers to obtain large current signal. Sensitivity to B_t and B_p is defined in the following equations

$$V = K_{B_t} \frac{\partial B_t}{\partial t} \qquad (1)$$

$$V = K_{B_p} \frac{\partial B_p}{\partial t} \qquad (2)$$

K_{Bt} and K_{Bp} are sensitivity to B_t and B_p.
The newly developed Rogowski coil has external diameter (20 [mm]), inner diameter (5 [mm]), K_{Bt} (8×10^{-6} [m^2]) , K_{Bt} (1×10^{-6} [m^2]) and 360 turn loops.

The unit of K_{Bt} and K_{Bp} is expressed in loop cross sectional area. Comparing the measured sensitivities and a calculation, we found that this new Rogowski coil is fabricated within the accuracy of $\pm$ 0.1 [mm].

In addition, we have successfully made and installed a Rogowski probe which has one Rogowski coil, five magnetic pickup coils and one Langmuir probes. The initial data of local current signal was obtained at ohmic heating plasma discharge (see Fig. 2). The local current at the plasma edge was observed about 150 [kA/m^2].
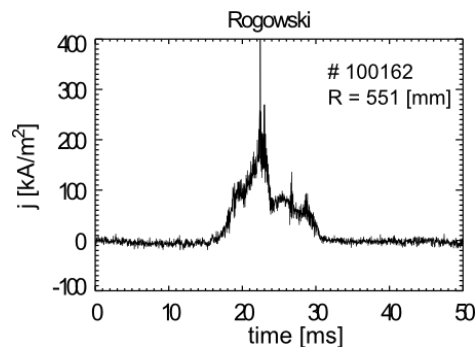

Fig.1 New Rogowski coil

Fig.2 Time evolution of local current at the major radius of R = 551 [mm]