01aA04

JT-60Uにおいて電子サイクロトロン波で生成した壁調整プラズマの特性
Characteristics of wall conditioning plasmas produced by electron cyclotron wave in JT-60U

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In the super conducting tokamak JT-60SA, wall conditioning with fundamental (X1-mode) and second harmonic (X2-mode) electron cyclotron (EC) waves is planned as an inter-shot wall conditioning method. Efficiency of the D_2 removal by the X1-mode electron cyclotron wall conditioning (ECWC) is higher than that by the X2-mode one in JT-60U. In this study, the causes of the efficiency difference of the D_2 removal are investigated.

Wall conditioning plasmas were produced in JT-60U by X1- and X2-mode EC waves with a frequency of 110 GHz. The toroidal magnetic fields, B_T, at a major radius with 3.32 m were set to be 3.65 and 1.86 T for the X1- and the X2-mode EC injection, respectively. The horizontal magnetic field, B_H, of B_H/B_T = 0.3% was applied to expand the plasma radially. Helium gas with 1.6 Pa･m^3 was injected before the 2.0 MW EC wave was injected from the outboard. Plasma shapes were observed by the tangential visible TV camera.

Figure 1 shows tangential visible TV images of the wall conditioning plasma produced by (a) X1- and (b) X2-mode EC wave. For the X1-mode case, plasmas produced along the electron cyclotron resonance (ECR) layer expanded radially by the B_H, and homogeneous plasmas were produced in the entire torus. For the X2-mode case, plasmas also expanded radially from the ECR layer, but these shrunk vertically. The plasma production in the entire torus should increase the efficiency of the D_2 removal by the ECWC with the X1-mode EC waves.

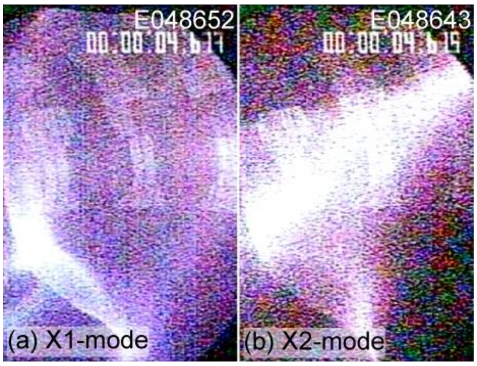

Figure 1. Tangential visible TV images of the wall conditioning plasma produced by (a) X1-mode and (b) X2-mode EC wave.

Single-pass absorption fractions of the X1-mode EC wave in plasmas were calculated to understand the process of plasma productions by the X1-mode EC wave, as shown in Fig. 2. The X1-mode EC wave cannot reach the ECR layer from the outboard, because the X1-mode EC wave is reflected by the low-density cut-off layer generated at the outboard from the ECR layer. Hence, the X1-mode EC wave should pass through the various vertical position of the ECR layer from the inboard by multi-reflections in random directions at the low-density cut-off layer and the outboard wall. Because the absorption fraction of the X1-mode EC wave is large for the wide toroidal injection angle of the EC wave, plasmas should be produced along the ECR layer. The plasma along the ECR layer is expanded radially by the B_H and is produced in the entire torus. The process of plasma production by the X2-mode EC waves is discussed at the conference.

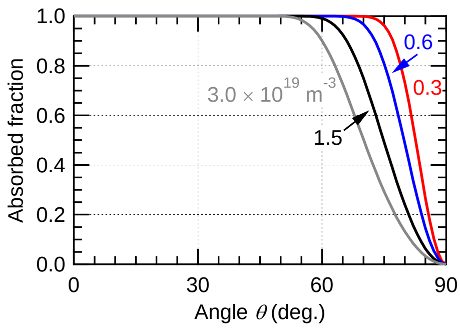

Figure 2. Calculated single pass absorption fractions of X1-mode EC wave in plasmas as a function of a toroidal injection angle of an EC beam with respect to toroidal magnetic field line at the ECR layer.