Measurement and analysis of helicon wave couplings for current drive in KSTAR

S. J. Wang, H. H. Wi, H. J. Kim, J. H. Jeong, and J. G. Kwak

NFRI, Daejeon, Korea

Helicon wave current drive is being tested for efficient off-axis current drive in high electron beta tokamak plasmas. Fast wave drives centrally peaking current in the frequency range up to several ion cyclotron harmonics in the present tokamaks, such as KSTAR. Increasing fast wave frequency up to LH resonance frequency at the plasma edge, the spiral propagation of wave at the outer region of plasma lengthens the wave path to the plasma center. [1] Also, optical thickness increases with frequency. It is expected that these effects produce efficient off-axis power deposition depending on the electron beta and magnetic field pitch. A low power TWA (traveling wave antenna) for helicon wave was installed and tested in KSTAR tokamak which is aiming for the steady-state high beta plasma requiring off-axis current drive. [2] The power coupling properties of TWA at various plasma conditions are measured and analyzed. The coupling is measured to be fairly high in both L-mode and H-mode plasmas. Issues such as load sensitivity and unwanted slow wave coupling are also addressed. The system is insensitive to mode transition, however ELM bursts cause too much loading. The variation of angle between Faraday shield and magnetic pitch in front of antenna does not affect coupling in the limited range. The analysis combining surface impedance of plasma and TWA agrees the measured high coupling well. Also, insensitivity on the pitch angle can be explained by the analysis showing far less contribution of O-mode polarization. The simulation of plasma performance with the combination of helicon wave current drive and other conventional heating and current drive power in KSTAR will also be discussed.