
Cutoff Probe for Process Monitoring

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In this paper, we present the recent progress of the cutoff probe research for the plasma process monitoring. This paper shows the whole progress for the cutoff probe including how to start to develop the cutoff probe in the initial period, what idea has been included during the development, how to evolve the probe during ten years, especially for plasma process monitoring. The cutoff probe was made by simple intuition for the cutoff phenomenon of the plasma wave. However, the unexpected complicated S21 spectrum gave big confusion for the cutoff frequency. At that time, just compared the cutoff probe result with the other probe result such as Langmuir probe and oscillation probe, the cutoff frequency could be determined. Later, EM wave simulation supported the validation for the cutoff frequency determination. Recently, by supposing the circuit modeling, the physics behind for the cut off probe spectrum (S21) was revealed and the accuracy and the application window of the probe were established. In addition to them, By cooperating with the accuracy measurement of the cutoff probe reactance, the e-n collision frequency as well as the electron density were calculated with good precision. The fast measurement cutoff probe "named fourier cutoff probe" which can be applied to the rapid change environment of plasma has been also developed. Based on recent developments we also introduce a novel methodology to interpret the probe spectrum that eliminates the sheath and collisional effects and enables the use of this precise diagnostic technique in a broad range of practical processing conditions. Recently developed new type of cutoff probe called planar cutoff probe is presented as well.