Characteristics of Various High-Density Helicon Sources and their Application to Electrodeless Plasma Thruster

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Because of high-density (~10^{13} cm^{-3}) and low electron temperature (from a few to several eV) available with a broad range of external operating parameters, helicon plasma sources [1,2], using an rf frequency range, are very useful. Various kinds of the sources have been developed and characterized by us to control plasmas as required: e.g., very large- [3,4] (up to 74 cm in diameter with an axial length of 486 cm) or very small-area [5,6] (down to 0.1-0.3 cm in diameter) sources can be found. Particle production efficiency in a wide range of plasma size showed an excellent performance [4], close to a classical diffusion coefficient. High-beta (~ 1) plasma can be easily achieved, showing an importance of neutrals effect [7]. Therefore, these sources can be expected to be utilized in vast areas from fundamental to application fields. Applying these sources to a space propulsion system with an advanced concept of an electrodeless condition (no direct contact between a plasma and electrodes/antennas) [4,6] has been executed, due to a longer life operation expected.

Here, we will overview our studies on various-sized, helicon plasma sources and their application to the electrodeless thrusters under the Helicon Electrodeless Advanced Thruster (HEAT) project [4,6]: Characteristics of very large or small (diameter) sources, and plasma thrust performance [6,8]. Here, a broad range of excitation frequency, 7-435 MHz, was used for optimization of plasma sources. In addition, some trials of electrodeless, additional acceleration methods are introduced, such as Rotating Magnetic Field (RMF) and $m = 0$ half cycle schemes [6], emphasizing the importance of some diagnostics.

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