Webinar: Why RF/Microwave Plasma?

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Abstract

Plasma, the 4th state of matter, is a gas in which some or all of its atoms and molecules are ionized. The resultant positively charged ions and negatively charged electrons are free to move under the influence of an electrical field, and hence the plasma is electrically conductive. Removal of a charged particle from the plasma creates an electrical field, which will pull the errant charge back towards the plasma, so that plasma tends to remain almost neutrally charged. Most of the known matter in the universe, including stars and interstellar material, is in the plasma state. Other naturally occurring plasmas include the ionosphere and the core of lightning strokes. Engineered plasma is applied for lasers and lighting, fuel ignition, and material processing. Plasma devices are being studied for controlled nuclear fusion, which has the potential of supplying "green" energy in the coming centuries.

Commonly d.c. electrical discharges such as glows and arcs are used to generate laboratory and industrial plasma. However, phenomena at the cathode can cause the discharge to be unstable (e.g. jump from the glow to the arc discharge), contaminate the plasma, and limit the device lifetime.

Electrodes can be eliminated by exciting the plasma at RF or microwave frequencies, coupling the RF or MW field into the plasma via an induction coil or waveguide. RF/MW excitation is complicated, however. Below a characteristic plasma frequency, which increases with the electron density in the plasma, the dielectric constant of the plasma is negative, and waves cannot easily penetrate, while above the plasma frequency, the dielectric constant is less than unity. To maintain the plasma, the electrical field must cause sufficient ionizing collisions of electrons with neutral atoms or molecules to balance loss of electrons from the plasma. Another complication is that standing waves can produce plasma at peak field regions, and not where a dominant mode has a null.

Microwave and RF plasmas are used industrially to produce coatings and thin films, and to synthesize materials, particularly diamond. RF heating of plasma for neutral beam injection is considered an important way to heat plasma to temperatures of 10 keV needed to start a thermonuclear reaction.

This Webinar is free-of-charge and open to the public, compliments of the International Microwave Power Institute. Registration is required.