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Generation of microplasma ensemble and its functional interaction with electromagnetic waves

OSAMU SAKAI, Kyoto University

Various patterns and structures of microplasma arrays were generated, and interactions between microplasmas and electromagnetic waves were investigated both for control of waves by microplasma ensembles and for production of microplasmas by waves. Using bipolar-voltage power supply with frequencies from several kHz to several MHz and insulated wires, several types of microplasmas were generated at atmospheric pressure with their electron density ranging from 10^{12} to 10^{13} cm^{-3}. They serve as equivalent dielectrics or metals according to their electron plasma frequency ranging from several GHz to several tens of GHz, with respect to the frequency of a propagating electromagnetic wave. When we installed such microplasmas forming a functional array in the propagation region of electromagnetic waves, microplasma arrays exhibited several types of performance; photonic crystals with band gaps, plasmonic waveguides, and metamaterials with extraordinary macroscopic permittivity and/or permeability. One of the significant advantages arising from use of microplasmas in a wave controller is their dynamic and tunable manner by changing external parameters such as generation power and working gas pressure. Especially rapid change of spatial generation patterns gives rise to transformation into another functional device. Another advantage is a role of complex functions arising from dispersion relations with frequency-dependent loss, which will lead to simultaneous and independent control of phase and attenuation of electromagnetic waves.