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Investigations on modulation of GHz electromagnetic wave propagation by sub-wavelength plasma structures

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In recent decades, the rapid advancement in nanophotonics and plasmonics has enabled controlling EM waves more flexibly and efficiently at the subwavelength scale in a variety of fields, including sensing, signal enhancement/attenuation/filtering, cloaking, etc. Such principles and techniques can be adapted to the microwave frequency regime when normalized key parameters (e.g., size, permittivity, and permeability) keep the same as those in visible bands of EM waves. As a special electromagnetic material, the permittivity of gaseous discharge plasmas has continuous tunability in a wideband spectrum in the GHz microwave regime. Especially, when the plasma frequency is higher than microwave signal frequency, i.e., the plasma is overdense, the real part of the complex plasma permittivity is negative, providing a possibility of exciting local surface plasmon resonance (LSPR) or surface plasmon polaritons (SPPs) at the plasma-dielectric interface. And thus, the sub-wavelength plasma structures show great potential in optimizing the modulation performance of GHz EM wave propagation. In this talk, basic theory and some typical applications of GHz electromagnetic wave controlled by sub-wavelength plasma structures will be introduced. Among which, the sub-wavelength plasma-based technologies of GHz electromagnetic wave radiation intensification, directional scattering control, as well as tunable bandstop filter will be highlight. The plasma parameter dependence of the optimal modulation technology is further investigated by experimental studies and numerical simulations. The relevant results demonstrate that the modulation of GHz electromagnetic wave propagation by sub-wavelength plasma structures exhibit important scientific significance and promising potential of broad applications in various areas, such as wireless information network, microwave communication and control technology, etc.

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