

Artificial Plasma in Applied Electromagnetics

*Olli Luukkonen
Nokia Research Center*

In this talk, I will cover several topics related to applied electromagnetics focusing on electromagnetic plasma applications. The properties of plasma, a gas composed of ionized particles, are well known. This type of properties can be found in various frequency bands for different types of materials, such as metals or semiconductors. When applying a static magnetic field across the plasma, non-reciprocal properties arise in this material. In properly designed systems this can lead to an extreme situation for which energy can travel only in one direction, that is, propagating modes exist only in one direction and energy entering the system from one end must exit it from the other. In possible applications, this would question the need for any additional impedance matching between the source and the load within the operational frequency band of the system. Wire medium, a structure that consists of a periodically organized lattice of parallel wires with certain lattice constant (or periodicity) and wire radius, has been used to mimic the interesting properties of plasma at microwave frequencies. The main difference between this artificial material and its model is that in the latter case the charge carriers are not bound whereas in the former case the charge carriers are bound – usually to a mesh structure that is dictated by the geometry. This leads to spatial dispersion, a commonly unwanted feature in artificial plasma. However, spatial dispersion can be suppressed in these structures, and in this talk I will discuss possibilities on how it can be done, especially in the context to artificial impedance surfaces. These surfaces, when properly designed, allow us to tune their electromagnetic response to fit the application in hand; whether it is an electromagnetic absorber for minimizing the radar cross-section of an object or a surface for enhancing the radiating properties of an antenna. Finally, some topics related to antenna and radar technology in mobile devices and possible future applications will be discussed.