Review of the Last Implementations of High-Gain Modulated Metasurface Antennas

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Modulated MTS antennas have emerged in the recent years as promising alternatives to classical antennas for satellite links, owning to their low cost, low profile, deep and effective capability of beam shaping and polarization control (G. Minatti *et al.*, IEEE Trans Antennas Propagat., 63(4), 1288-1300, April 2015). Modulated MTS antennas at microwave frequencies are usually formed by a dense texture of small metal patches, distributed on a Cartesian lattice, printed on a grounded slab. The slab is extremely thin, around one twentieth of the free space wavelength at the operative frequency. Patches have variable size and shape, gradually forming a quasi-periodic modulated impedance sheet, with tensorial capacitive nature. A surface wave (SW) excited on the grounded slab interacting with the MTS is transformed into a leaky wave with controlled radiation pattern. The SW is provided by a vertical dipole, top-loaded with a slotted patch to improve impedance matching and to maximize the amount of energy launched as a SW. The overall antenna is hence extremely flat and simple, and it can be realized with standard PCB techniques.

In this work, we review design, implementation and testing of some recent very high gain modulated metasurface (MTS) antennas developed for Ka-band satcom applications. In particular, we will discuss experimental results relevant to high gain MTS antennas prototypes developed in the frame of the ESA ARTES 5.2 project “Ultra flat VSAT antenna for institutional and civilian applications”. The proposed solution, consisting of the combination of a transmitting and a receiving aperture accommodated on a single panel, is a planar alternative to parabolic dishes. It is especially advantageous in those applications such as safety and surveillance where minimization of environmental and visual impact can be an issue.

During the presentation, the discussion will first review the key-points of the design process of MTS antennas. These latter include a preliminary design based on a continuous impedance boundary condition (IBC) model and performed with a quasi-analytical approach (G. Minatti, *et al.*, “Synthesis of Modulated-Metasurface Antennas With Amplitude, Phase, and Polarization Control,” IEEE Transactions on Antennas and Propagation, vol. 64, no. 9, pp. 3907-3919, Sept. 2016), full wave simulations carried out with a MoM code for continuous IBC (D. González-Ovejero and S. Maci, “Gaussian ring basis functions for the analysis of modulated metasurface antennas,” IEEE Trans. Antennas Propag., vol. 63, no. 9, pp. 3982–3993, Sep. 2015) and full wave simulations taking into account the actual patch implementation of the IBC. Next, experimental results will be presented and compared with simulations to demonstrate the effectiveness of the design approach. Losses and efficiency of the realized prototypes will be also discussed.