Metamodulation for Ultralarge Bandwidth

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In quite recent times, remarkable attention and effort have been directed by the Electromagnetic Community to develop a new class of planar Leaky Wave Antennas (LWAs), exploiting artificially built impedance surfaces to implement equivalent periodically modulated Impedance Boundary Conditions. This antennas are often referred to as Modulated Metasurface (MTS) Antennas. The aperture is indeed constituted by a thin grounded dielectric environment perturbed by regular printing of periodic slowly modulated electrically small elements.

The possibility of acting on the MTS in order to control the macroscopic electromagnetic surface characteristics, hence to control the supported fields properties, opened to the capability to accurately control and customize the propagation features, the radiation rate and the polarization of the induced leaky wave. MTS antennas hence emerge as truly flexible, powerful devices to be employed in a number of different applications. Other key points of their success are conformability to curved structure, low bulkiness, lightness, low cost and operability by embedded and easy feeding.

Recently, much work has been devoted to improve the design systematization by more accurate MTS analysis; simultaneously, more effective approaches for aperture field synthesis and hence equivalent aperture definition have been proposed, as for example in [Minatti, Gabriele, et al. Synthesis of modulated-metasurface antennas with amplitude, phase, and polarization control. *IEEE Transactions on Antennas and Propagation* 64.9 (2016): 3907-3919.]. Improved phase and polarization control allowed for dealing with even demanding requirements such as shaped patterns syntheses and highly efficient apertures.
Anyway, despite the considerable improvements of modulated MTS antennas technology and its great flexibility, this typology of LWAs generally currently suffers from bandwidth limitation, as quite fast pattern degradation occurs as the antenna operative frequency is changed. Solutions available are limited to operative bandwidths of around the 5% for gains around 30dB (intended as the pattern bandwidth). It is noticed that pattern degradation, more than being due to intrinsic structure resonance, occurs from progressive mismatch between the surface modulation period and the radiating mode phase, thus originating progressive depointing.

The purpose of this paper is hence to propose a new design strategy able to address improved pattern stability for MTS antennas over sufficiently large bands. In this case, the available aperture is exploited for implementing a continuously stretched impedance modulation or, in other words, a "chirped" modulation, whose phasing is locally matched to the SW phase, and hence enabling the desired pointing, over the desired frequency range. This kind of solution proved to be quite effective in MTS antenna bandwidth enlargement. More details relevant to the modulation shape and pattern results will be discussed at the Conference.