URSI GASS 2020, Rome, Italy, 28 August - 4 September 2021

Perfect Energy Conversion from Surface-Wave to Leaky-Wave in Periodic Metasurfaces

Svetlana N. Tcvetkova[(1)], Enrica Martini[(2)], Sergei A. Tretyakov[(1)], Stefano Maci[(2)]

(1) Department of Electronics and Nanoengineering, Aalto University, P.O. 15500, FI-00076 Aalto, Finland
email: sergei.tretyakov@aalto.fi svetlana.tcvetkova@aalto.fi

(2) Department of Information Engineering and Mathematics, University of Siena, 53100 Siena, Italy
email: enrica.martini@unisi.it, stefano.maci@unisi.it

This paper presents an exact solution for a perfect conversion of a TM-polarized surface wave (SW) into a TM-polarized leaky-wave (LW) or TE polarized LW using a reciprocal and lossless penetrable metasurface (MTS) characterized by a scalar sheet impedance, located on a grounded slab. The present formulation complements a previous paper of the authors [1] in which a perfect conversion from TM-polarized SW to TE-polarized LW was found for *impenetrable* boundary conditions. In contrast to known realizations of leaky-wave antennas, the optimal surface reactance modulation which is found here ensures the absence of evanescent higher-order modes of the field Floquet-wave expansion near the radiating surface. Thus, all the energy carried by the surface wave is used for launching the single inhomogeneous plane wave into space without accumulation of reactive energy in the higher-order modes. It is shown that the resulting penetrable MTS exhibits variation from an inductive to a capacitive reactance passing through a resonance. The solution here takes into account the grounded slab dispersion and it is convenient for practical implementation.

Our solution has been found by imposing a reactive balance of the wave coupling in the absence of losses. The found impedance can be synthesized in order to ensure a certain beam direction and decay rate. Since along the direction of propagation, the solution exhibits alternance of positive and negative values around a certain impedance average, it passes through a resonance at each period. This suggests a possible realization of this impedance, which consists of a periodic distribution of printed subwavelength slots elements, with some of them close to resonance. Since the presence of these periodic resonances in the impedance, a sensitivity study is carried out to check the deterioration of the two-mode only solution when the ideal impedance is not perfectly implemented cose to the resonances.

References

[1] S. N. Tcvetkova, S. Maci, and S. A. Tretyakov, “Exact solution for surface wave to space wave conversion by periodical impenetrable metasurface” *IEEE Transactions on Antennas and Propagation,* Vol 67, issue 5, May 2019.