How to transform an EBG surface to a soft or hard surface and thereby improve its STOP or GO characteristics

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Sometimes electromagnetic bandgap (EBG) surfaces are used to reduce coupling or remove surface waves, which we herein refer to as a STOP characteristic. In many such cases the performance will be better if the EBG instead was made anisotropic like a soft surface, because the soft surface has STOP characteristics for all polarizations. Other times opposite walls of a rectangular waveguide are made of EBG surfaces to make them support quasi-TEM waves, herein being referred to as a GO characteristic. In such cases the performance will be better if the EBG walls (or preferably all walls) were made like hard surfaces, because the hard surface has GO characteristics for all polarizations. In both these two cases the EBG is normally behaving like an artificial magnetic conductor, whereas the soft or hard surface always can be represented by a PEC/PMC strip grid oriented transversely or longitudinally, respectively, with respect to the propagation direction of the wave along the surface. The purpose of the present paper is to define the STOP and GO characteristics of high impedance EBGs that are realizations of artificial magnetic conductors (AMCs), and soft/hard surfaces. We will also show by computation and measurements how to transform an AMC to a soft/hard surface.

We have taken a dual layer high impedance surface (i.e. an AMC) of mushroom type and measured the transmission between two vertical monopoles and two horizontal dipoles located on top of it. The measurements were repeated on a metal surface (i.e. PEC) of the same size, and on the AMC when this was provided with thin parallel metal strips (Aluminum tape) to obtain a soft/hard surface. We could then easily verify that the STOP characteristics are generally better for the soft surface than for the AMC, and that the GO characteristics are better for the hard surface. In the former case there is an exception, namely suppression of TEM waves between parallel plates, which is normally better with an AMC than a soft surface.

We have also computed the couplings with three moment method codes for the ideal cases of PEC, PMC, soft and hard surfaces. This could not easily be done, because commercial codes cannot normally model PMCs of finite extent and arbitrary shape, and certainly not soft and hard surfaces by a PEC/PMC strip grid. We have, however, built the latter model into an in-house code. It is desirable that commercial codes get these possibilities as well. The results are generally in agreement with the measurements, but not in detail, because we did not try to model the frequency behavior of the EBG. When working with EBGs, AMCs and soft/hard surfaces it is always desirable to know the performance that can be obtained for the ideal cases, before starting the laborious work of realizing the EBG. Therefore, commercial codes should be extended to allow such computations, which also are much faster than modeling the surfaces in all details.
More about measurements and computations of these surfaces and applications can be found in (P-S. Kildal and A. Kishk, invited lecture in plenary session at ACES Conference, Monterey, March 2003, to appear in a special issue of the ACES journal).