

A material approach to high-impedance metasurfaces

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High-impedance surfaces (HISs) typically consist of metamaterial constructs with high values (theoretically diverging) of the wave impedance, $Z \rightarrow \infty$. In many ways, HISs are the opposite case to a good conducting material, for which $Z \rightarrow 0$, and reproduce the boundary conditions of a perfect magnetic conductor (PMC). In this manner, the tangential electric field to the surface is enhanced, instead of being inhibited as in good conducting materials. This simple behavior enables the design of multiple low-profile devices, including thin-film absorbers, antennas and anti-radar systems [1-2].

However, the finite size of their constitutive unit-cell imposes several limitations on the technological implementation of HISs. First, HISs require from complex nanofabrication process for operation at optical frequencies, hindering their large scale / large area deployment. Furthermore, metamaterial constructs suffer from spatial dispersion, and an associated nonlocal response. Finally, the finite size of the unit-cell might limit the integrability of HISs on conformal devices.

The use of a material-based HISs presents a radically different approach. In essence, the medium impedance diverges for a material with a near-zero permittivity, $Z = \sqrt{\mu/\varepsilon} \to \infty$, as $\varepsilon \to 0$, usually referred to as epsilon-near-zero (ENZ) media [3]. Material-based HISs do not suffer from the restrictions in fabrication, spatial dispersion and geometry than their metamaterial counterparts. However, the intrinsic losses of ENZ materials limit the how high the impedance can be. In our presentation, we will review our latest efforts on developing material based high-impedance metasurfaces for control of thermal emission. We recently experimentally demonstrated how silicon carbide (SiC) can act as an intrinsic high-impedance surface, enabled efficient absorption in ultra-thin film metallic layers [4]. Additional technological advantages our approach is operation with conformal substrates. In addition, we have theoretically predicted that ENZ media intrinsically enhances the spatial coherence of thermal fields, enabling directive and partially coherent emission, while preserving geometrical flexibility [5].

References

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