

Increased Local Density of States and Electromagnetic Well Effect by Using Very Thin Hyperbolic Metamaterial

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Hyperbolic material (HM) is proven to dramatically increase the power emitted by a source near its surface or inside it. Moreover, the power emitted by a source is mostly directed into the HM thanks to a very wide spatial wave spectrum that is allowed to propagate, and carry power, inside the HM. These exotic properties of HM gained a great interest for applications such as increased rate of spontaneous emission by dye molecules, or novel and improved absorbers, both at microwave and optic frequencies. Here we show the impact of the thickness of a HM substrate on the power emitted by a source close to its surface in order to explore the principles for decreasing the thickness of HM based designs. We initiate the analysis with vertical and transverse dipoles located at a certain distance from the surface of a homogeneous HM substrate grounded at the bottom. Then the same analysis is extended to a realistic HM design with metal/dielectric multilayers by using transmission line formalism of TE and TM waves (thus taking the heterogeneity of the layered medium into account). The spatial spectrum of the power directed into HM is shown to possess different distributions for HM substrates with different thicknesses; however the amount of the total emitted power and the ratio of power directed towards the HM substrate exhibit little dependence on the thickness of the substrate. This important result proves that very thin HMs are a new promising technology for enabling engineers to design extremely thin absorbers.