Subwavelength Tunneling of Electromagnetic Waves

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Under certain conditions, the transmission of electromagnetic waves through subwavelength metallic meshes was enhanced. The metallic mesh (hereby referred to as layer B) is sandwiched between two identical layers in three configurations: split ring arrays, metallic plates with periodic fractal slots, and plastic plates with periodic metallic fractals. The *split rings/metallic mesh/split rings* structure demonstrates some unique electromagnetic (EM) characteristics. It is found that the transmittances of EM waves are significantly enhanced at certain frequencies near the stop bands of the split rings. While the metallic plates with periodic fractal slots (layer A) and plastic plates with periodic fractals (layer C) are a complementary pair (ie an inverse version of each other), in an ABA or CBC configuration, the composite is found to exhibit multiple transmission peaks which do not appear when layer B alone is used. The phenomena of subwavelength tunneling is caused by electromagnetic enhancement at and between the interfaces of the different layers, induced by local resonances of the two outer plates. The simulations indicate that, for the *split rings/metallic mesh/split rings* structure, two different physical mechanisms are responsible for the transmissions: negative refractive index effect, and electromagnetic wave tunneling when EM waves penetrate through negative permittivity substrates sandwiched between two high permittivity slabs. For the ABA and CBC configurations, the nature of the resonance, electrical or magnetic, is a determinant of locating the transmission peak of the composite, either on the left or the right of the sandwiching layer.

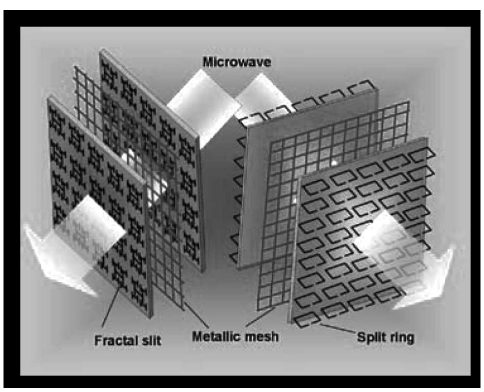

Figure 1: The structural configurations of sandwiched EM metamaterials.

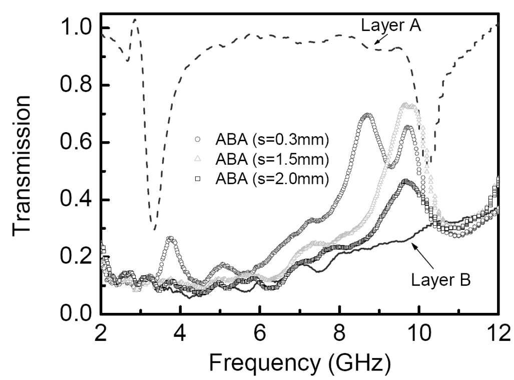

Figure 2: The measured normal transmissions of layer A and B as well as the ABA layers at various separations.