Magnetically Tunable Composites Exhibiting a Pseudo Plasmonic Resonance.

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In this work we present new tunable magnetic plasmonic metamaterials based on dielectric-magnetic/conductor composites. Its particular microstructure allows a close control of the conductivity around the percolation threshold. However, the more striking property is its apparent capacity (as measured from impedance analyzer), which takes values close to zero at the low frequency limit (<100 MHz), but more importantly, this value can be modified in real time by the effect of a static magnetic field.

In order to fabricate materials this materials, composites based on a magnetic oxide matrix, in this case NiZn ferrite, were modified by the inclusion of small amounts of carbon nanoparticles, (graphene sheets or nanofibers). We have found that in these system, there exist a narrow range of carbon concentration corresponding to intermediate values of conductivity (σ~1 $\Omega^{-1}m^{-1}$) for which the "apparent" real part of the capacity is near to zero, and even its sign be modified in a continuous way by the effect of a static magnetic field (H<2000Oe) .

This tunable "apparent permeability" caused by a magnetic field reassembles the effect of the depolarization field in the well-known Surface Plasmon Resonances (SPR). Actually, in these composites, the applied current generates an a.c. magnetic field and consequently an electric field opposed to the external field in a similar way as the depolarization field does it in SPR (see figure *a*). Because the composite has a ferromagnetic phase, its self-inductance depends on the permeability and consequently the effect of a magnetic field is enough to notably modify this value, so that, the magneto-electric depolarization field and its apparent permittivity can be tuned by the effect of a static magnetic field.

Experimental results referring to the magnetic control (see figure *b*) of the apparent capacity show a continuous variation of this magnitude as a function of a externally applied field. Finally, some discussion about the possible applications of this kind of materials will be exposed.

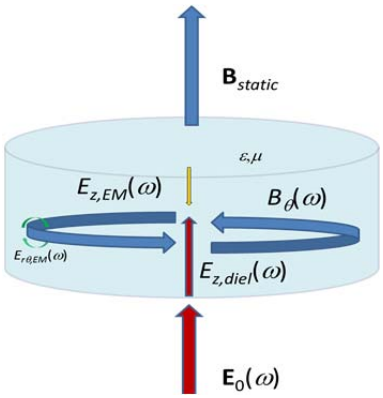

Fig.*a* Field distribution in a cylindrical capacitor.

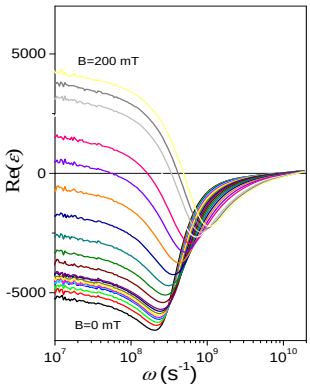

Fig.*b* Apparent permittivity of composites under different static magnetic fields.