Modeling of plasmonic coatings in RCS computations

P. Soudais[1], C. Saint-Flour[2], and O. Vacus*[2]

[1] Dassault Aviation, quai Marcel Dassault, 92 552
SAINT-CLOUD, France

[2] CEA/CESTA, 33 114 LE BARP, France

As far as RADAR Cross Section (RCS) computations are concerned, meshing inclusions much smaller than the wavelength of interest λ to model microscopic details often leads to untractable problems when target dimensions are much greater than λ. Consequently equivalent material parameters are necessary, and they can be derived from "effective medium approximations" (EMA). In this work we focus on EMA introduced by Pendry *et al.* ("Mimicking surface plasmons with structured surfaces", *Science,* vol. 305, p. 847, 2004) and further investigated by Garcia-Vidal *et al.* ("Surfaces with holes in them: new plasmonic metamaterials", *Journal of Optics A,* vol. 7, p. S97-S101, 2005) in relation with perfect electrical conductors perforated with grooves. The EMA anisotropic dielectric permittivity can be deduced from extended Bruggeman theory. The EMA magnetic permeability must be modified to correct the effective index: the product $\varepsilon\mu$ is forced to be equal to 1 so as to ensure a correct phase velocity in the grooves.

Our goal is to test these EMA results in RCS computations, by considering spheres and cone-spheres in the microwave domain. A comprehensive study is proposed using three different numerical tools.

The first one is expected to provide a reference solution to the scattering problem. This requires a precise meshing of the geometry of the coating of interest, which is possible in the 2-D case only (rotational symmetry around one axis at least). The second one ignores the fine details of the coating and is used to test different EMA. Both models can run on a non-commercial code named SHFC based on a formalism involving a strong coupling of integral equations (method of moment) and finite volume elements; under the 2-D axi-symmetrical object assumption CPU time consumption remains low while producing accurate RCS. The third tool is a 3-D integral equations code which takes into account the anisotropic EMA with a tensorial impedance boundary condition.

Results on very anisotropic EMA (such as tensor ϵ_r with diagonal terms equal to $[5; 10^6; 10^6]$ and tensor μ_r with diagonal terms equal to $[1; 0.2; 0.2]$) show that both approximate approaches, namely anisotropic volume EMA and tensorial IBC, yield accurate results.

Part of these results is currently being submitted for publication ("RCS computations of targets with plasmonic coatings", to *IEEE trans. Ant. Prop.* in December 2014).