Surface-Volume-Surface Electric Field Integral Equation for Solution of Scattering Problems on 3D Composite Metal-Dielectric Objects

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A formulation of the Surface-Volume-Surface Electric Field Integral Equation (SVS-EFIE) for solution of the scattering problems on composite piece-wise homogeneous penetrable dielectric objects has been recently developed (Chen, Gholami, Okhmatovski, IEEE AWPL, 2018). In this work we generalize the SVS-EFIE formulation to the case of piece-wise homogeneous scatterers which feature both penetrable dielectric regions and impenetrable metal regions. Independent electric surface current density is introduced on the boundary of each region forming the scatterer. While on the metal regions this electric surface current density is equal to the tangential component of the magnetic field $\hat{n} \times \bar{H}$, the electric surface current densities on the boundaries of the homogeneous dielectric regions are fictitious functions which are equal to the jump of the tangential component of the true magnetic field inside the region and unconstrained magnetic field outside the region. On the common boundaries between two dielectric regions two independent fictitious surface electric current densities are introduced. On the common boundaries between the metal and dielectric regions two independent surface electric current densities are introduced also. However, while on the surface of the metal the electric current density has a clear physical meaning of $\hat{n} \times \bar{H}$, the surface current density on the dielectric region is fictitious. The fact that on the common boundaries the surface current densities of each region are independent of each other brings two advantages when it comes to numerical solution of the SVS-EFIE in comparison to the numerical solution of the classical surface integral equation formulations such as PMCHWT, Muller, or others. First, this independence of the unknown currents eliminates the problem of the current discretization at the material junctions. Second, the boundaries of the regions can be meshed independently and in correspondence with the material properties of their respective region. Numerical validation of the proposed novel SVS-EFIE formulation will be presented at the symposium as well as demonstration of the aforementioned advantages.