From Cloaking of Conducting Cylinder to RCS Reduction/Enhancement

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The concept of cloaking (aka electromagnetic invisibility) a conducting cylinder was first introduced via the transformation-optics method (J.B. Pendry, D. Schurig, and D. Smith, Science, 312, 1780-1782, 2006). It requires complex metamaterials with subwavelength structured inclusion to realize high unisotropy/inhomogeneity of the material parameters. To substitute the unisotropy materials, a concentric multi-layered structure of alternating homogeneous isotropic materials was introduced (Y. Huang, Y. Feng, and T. Jiang, Opt. Express, 15, 11133-11141, 2007). However, it still requires materials with very low (close to zero) or high permittivity, which are only available at infrared and visible optical frequencies. Nevertheless, the size of the conducting cylinder is not limited with the above cloaking methods.

Recently, a single or five-layered (with linear profile) isotropic lossless dielectric/ magnetic cladding was shown to partially cloak an electrically small sized conducting cylinder (C. Valagiannopoulos and P. Alitalo, IEEE APSURSI, 2012; also Phys. Rev. B, 85,115402, 2012). For assessing the cloaking performance, Valagiannopoulos and Alitalo also introduced a 'crucial quantity' called σ_{norm} which is defined as the total scattering width of the cloaked structure normalized by the corresponding width of the conducting cylinder. It should be noted the TE (transverse electric) polarization defined by all the above mentioned references is with respect to the propagation direction not the cylinder's axis as in (R. Harrington, Time Harmonic Electromagnetic Fields, McGraw-Hill, N.Y., 232-235, 1961.)

In this paper, the bistatic Radar Cross Section (RCS), extensively used by the antenna/ radar engineers, will be computed via the standard separation of variables method to assess the cloaks proposed by Valagiannopoulos and Alitalo in the above mentioned references. It will be shown that their improved cloaks still have very strong back-scattering RCS. However, with the lossy dielectric/magnetic cladding material, the back-scattering RCS is reduced significantly. In addition, it will be presented that the RCS reduction/enhancement of a conducting cylinder can be achieved by adding a single layer of isotropic lossless/lossy dielectric around the conducting cylinder similar to the RCS results published in (T.K. Wu and L. Tsai, IEEE Trans., AP-25, 516-524, 1977).