The interaction of electromagnetic waves and three-dimensional non-isotropic (uniaxial) wire medium metamaterials based on a transport model

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The transport model for the wire medium is introduced in (*IEEE Trans. on Antennas and Propagation*, v. 60, pp. 4219-4239, Sep. 2012) and basically defines an equivalent diffusion parameter (D) and a conductivity (or permittivity) for an isotropic wire medium satisfying the drift diffusion equation

$$\mathbf{J}^{cond}(\mathbf{r},\omega)=\sigma(\omega)\mathbf{E}(\mathbf{r},\omega)-D(\omega)\nabla\rho^{cond}(\mathbf{r},\omega)$$

in which, $\mathbf{J}^{cond}$, $\mathbf{E}$, and ρ are homogenized conduction current, electric field, and charge inside the wire medium, respectively. Using this model we have shown previously that scattering problem formulations become simpler and less computationally intensive compared to other real-space methods. The validity of this homogenization method was confirmed for the isotropic wire medium sphere and was compared to the ABC method and the full wave simulation results in previous presentations (URSI 2012 meetings at Boulder and Chicago).

The method is extended here for the uniaxial wire medium. Scattering from spherical objects illuminated from different angles are investigated, and the problem formulation and proper boundary conditions are discussed. Also, the effect of the polarization of the incident field is investigated, which was not important for the isotropic case.

As a simpler two dimensional example, reflection and transmission from a slab of uniaxial wire medium is also investigated. Similar to the spherical case, polarization, angle of the incident wave, and the orientation of wires inside the slab are important factors which are discussed.
Measurement results and their comparison with our model and full wave simulation for isotropic and uniaxial wire medium will be discussed as well.