Homogenization of a thin layer of randomly distributed nano-particles : effective model and error estimates [1]

Amandine BOUCART, Poems, ENSTA, IP Paris - Palaiseau
Sonia FLISS, Poems, ENSTA, IP Paris - Palaiseau
Laure GIOVANGIGLI, Poems, ENSTA, IP Paris - Palaiseau

We study the time-harmonic scattering by a heterogeneous object covered with a thin layer of randomly distributed nanoparticles. The size of the particles, their distance between each other and the layer's thickness are all of the same order but small compared to the wavelength. Solving numerically Maxwell's equation in this context is very costly. Moreover, we do not have access to the distribution of particles on a given object. To circumvent these difficulties, we propose, via a multi-scale asymptotic expansion of the solution, an effective model where the layer of particles is replaced by an equivalent boundary condition that does not depend on the random realisation.

The coefficients that appear in this equivalent boundary condition depend on the solutions to corrector problems of Laplace type posed on unbounded random domains. Under the assumption that the particles are distributed given a stationary and ergodic random point process, we prove that those problems admit a unique solution in the proper functional spaces with both Dirichlet (for $d \geq 2$) and Neumann boundary conditions (for $d = 3$) on the particles. We then establish quantitative error estimates between the original and effective solutions providing that the distribution of particles verifies a quantitative mixing condition.

[1] A. Boucart, S. Fliss, L. Giovangigli. *Scattering from a random thin coating of nanoparticles : modeling, asymptotic analysis and numerical simulations.* en préparation, 2022.

Contact : `laure.giovangigli@ensta-paris.fr`