Designing multi-layer polymeric nanocomposites for electromagnetic shielding

Designing multi-layer polymeric nanocomposites for electromagnetic shielding

F. Van Loock[1], P.D. Anderson[1], R. Cardinaels[1,2]

[1]Polymer Technology, Department of Mechanical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600MB, The Netherlands

[2] Soft Matter Rheology and Technology, Department of Chemical Engineering, KU Leuven, Celestijnenlaan 200J, 3001 Heverlee, Belgium

The ever-growing number of radiative, inter-communicative electronic devices in the GHz regime has exacerbated the modern day issue of electromagnetic pollution, rendering a range of challenges for the new smart age: preserving signal fidelity (smart automotive), reducing emission levels and ensuring efficient shielding to secure environments (defense, medical facilities). This research focuses on the experimental analysis and modelling of multi-layered electromagnetic (EM) polymer nanocomposites, operational in the X-band with an efficient modular approach thereby demonstrating that the spatial order inherent in 2D systems can be well exploited to generate reflective and absorptive functionalities. In the first part of the work, the nanocomposites consist of a polymer matrix (polymethylmethacrylate) filled with conductive carbon nanotubes. Different multi-layered polymeric nanocomposites, consisting of stacks of nanocomposite slabs with different compositions are prepared via extrusion followed by compression moulding. Their electromagnetic characteristics are measured inside a waveguide using a vector network analyzer. An analytical model and numerical finite element simulations are used to optimize the stacking order and nanocomposite composition. In the second part of the work, the focus will shift towards 3D systems prepared via additive manufacturing. The latter technique opens up several unexplored regions of the design space in terms of possible structures to incorporate electromagnetic metamaterial behaviour.

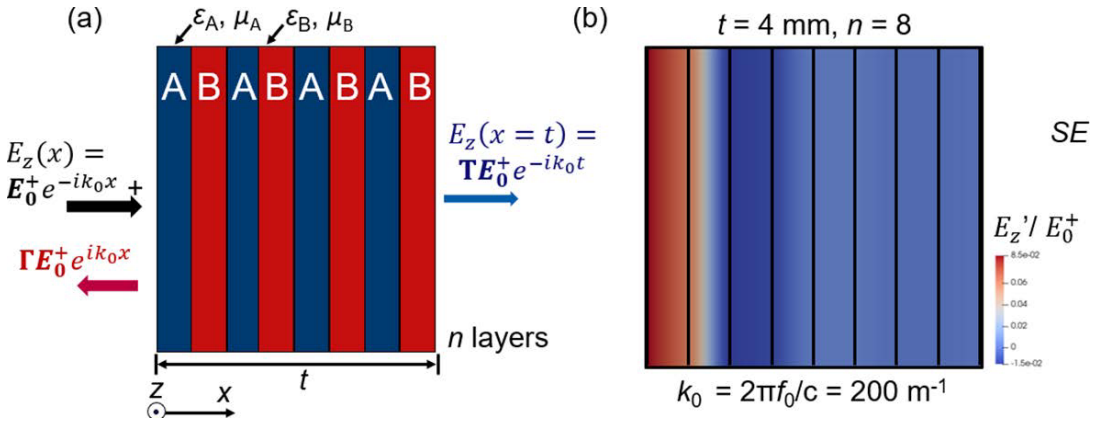

Figure 1: a) Example of a simple multi-layer structure consisting of alternating ABAB layers, b) Amplitude of the electromagnetic wave inside the material