

Designing multi-layer polymeric nanocomposites for electromagnetic shielding

Citation for published version (APA):

Van Loock, F., Anderson, P. D., & Cardinaels, R. (2022). *Designing multi-layer polymeric nanocomposites for electromagnetic shielding*. Poster session presented at Metamaterials: Designing wave propagation with a focus on electrodynamics, WE-Heraeus-Seminar, Bad Honnef, North Rhine-Westphalia, Germany. https://www.we-heraeus-stiftung.de/fileadmin/Redaktion/PDF/Seminare/2022/760_Booklet.pdf

Document status and date:

Published: 01/02/2022

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

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Designing multi-layer polymeric nanocomposites for electromagnetic shielding

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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.

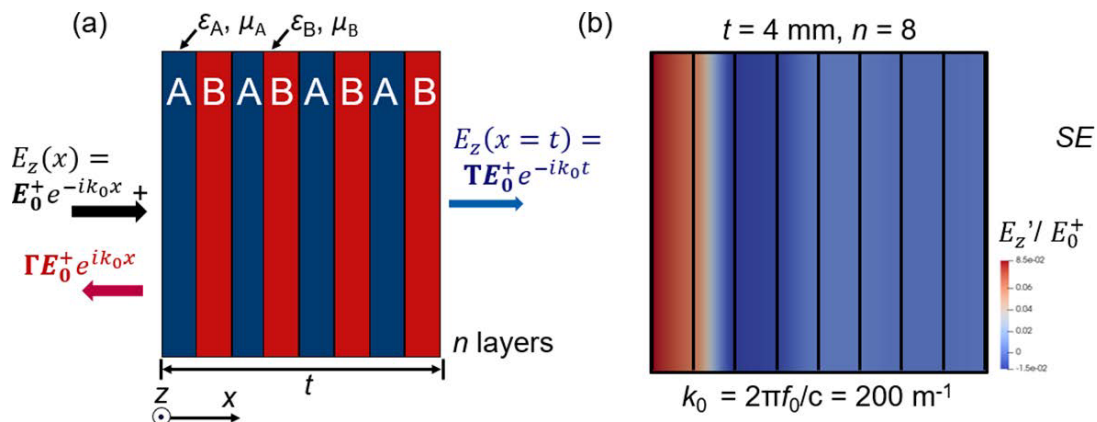


Figure 1: a) Example of a simple multi-layer structure consisting of alternating ABAB layers, b) Amplitude of the electromagnetic wave inside the material