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Editorial

Special Issue: Advances in Computational Electromagnetics

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Recent advances in computational electromagnetics (CEMs) have made the full characterization of complex magnetic materials possible, such as superconducting materials, composite or nanomaterials, rare-earth free permanent magnets, etc. Such advances are found in the collection of papers from this Special Issue, where vector properties and the non-linearity of ferromagnetic materials are investigated in [1–4], while new composite materials for automotive and aircraft are envisaged in [5,6], respectively. Finally, novel deposition techniques for nanomaterials using nonuniform magnetic fields are addressed in [7].

First of all, Anatoli A. Rogovoy and co-workers [1] considered the behavior of a Ni_2MnGa ferromagnetic material in the framework of microstructural modeling by means of the finite element method (FEM). Starting from a non-magnetized wall domain structure, they investigated its behavior (motion of domain walls and their interaction) and constructed the averaged magnetization curves under the action of an external magnetic field applied in different directions from the anisotropy axis. The obtained results with FEM were in agreement with the ones available in the current literature, demonstrating the validity of their approach. Staying in the field of ferromagnetic materials, but with the aim of characterizing their hysteresis loops, D'Aloia and co-workers [2] and Quondam Antonio and co-workers [3] presented two novel and efficient approaches to deal with. The former was conceptually inspired by the classical Preisach model, but with a more efficient phenomenological representation of the so-called Barkhausen jumps based on velocity jumps between two colliding disks. This allowed them to obtain a simple differential formulation for the global magnetization equation with a significant improvement in terms of computational performance. Moreover, temperature variations on magnetization were easily account for and therefore the application of their proposed method to the hysteresis loop of a real *NdFeB* magnet was shown to be very accurate and efficient for a large temperature range. The latter instead proved to be very effective for a specimen of innovative *Fe-Si* magnetic powder material. The experimental data relative to the circular loops were utilized to identify a vector model of hysteresis based on feedforward neural networks (NNs). The comparison between calculated and measured loops evidenced the capability of the model in both the reconstruction of the magnetic field trajectory and the prediction of the power loss under various excitation waveforms. To finish the characterization of ferromagnetic materials, Aldo Canova and co-workers [4] proposed an optimal design procedure for magnetically shielded rooms (MSRs) made of *grain-oriented* (*GO*) electrical steel. A numerical model based on fixed point iterative method to simulate the shielding efficiency of a MSR was presented and experimentally tested.

Advances in CEMs for innovative materials in automotives have been exploited in [5]. Specifically, the safety compliance of a wireless power transfer (WPT) system aimed to recharge a compact electric vehicle (EV) has been evaluated. The magnetic field emitted by the WPT system was calculated with a hybrid scheme coupling the boundary element method (BEM) with the surface impedance boundary conditions (SIBCs) in order to fit the thin and complex shape of the EV. The authors modeled the chassis either as a currently employed *aluminum alloy* and as a futuristic *carbon fiber* composite panel.

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Mingda Zhai and co-workers [6] instead employed numerical techniques based on FEM to design a magnetic suspension balance system (MSBS) needed to suspend an aircraft in the wind tunnel without contact. The electromagnetic force used to suspend the aircraft was optimized by tuning the diameter and the spacing of the axial coil made of copper, as well as the number of segments and the pitch angle of the suspension model magnet made of *NdFeB*.

Finally, Giovanni Marinaro and co-workers [7] presented an experimental, theoretical and numerical model of oscillatory copper deposition on a conically shaped iron probe under a non-uniform magnetic field for realizing nano-structured materials and nano-particles. Thanks to numerical simulations based on FEM, the authors showed that the oscillations are caused by the magnetic gradient, Lorentz force, and buoyancy force counteracting one another, and the oscillation frequency was estimated analytically based on this mechanism. The results of this study may stimulate future research aimed at the local control of the deposition rate and the realization of miniaturized, regularly structured deposits of nano-structured materials using magnetic fields.

I hope that this Special Issue of *Magnetochemistry*, devoted to the latest advances in computational electromagnetics, will be pleasant and useful to both specialist and non-specialist readers. I wish to thank the authors for providing such impressive and interesting papers and the referees for their time and valuable comments.

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