248 Modelling the effect of plasticity on the magneto-elastic behaviour of magnetic materials

Laurent Daniel, Mathieu Domenjoud
Université Paris-Saclay, CentraleSupélec, CNRS, Laboratoire de Génie Electrique et Electronique de Paris, Gif-sur-Yvette, France; Sorbonne Université, CNRS, Laboratoire de Génie Electrique et Electronique de Paris, Paris, France

The properties of electro-mechanical systems are intimately linked to the mechanical state of the magnetic materials used for their design. Notably, the processing stages can lead to significant mechanical stresses, which strongly impact the final magnetic behaviour, through plasticity and residual stress effects. In this presentation, a new modelling approach for the effect of plastic strain on the magneto-elastic behaviour of magnetic materials is proposed. The model incorporates the effects of both internal stresses and dislocation density. Comparison between modelling and experimental results obtained on an electrical steel show that the modelling tool can notably be used to predict the effect of a reloading stress on the magnetic behaviour of a plasticized material. The very low computation cost of the modelling approach makes it suitable for the numerical study of magnetic devices under various mechanical states. In addition, this formulation opens a route for estimating the mechanical state of a plastically deformed material through the analysis of its magnetic behaviour.

249 Modeling size effect in miniaturized mass sensors

Hossein Darban, Michał Basista
Institute of Fundamental Technological Research, Polish Academy of Sciences, Poland

Micro- and nanocantilever resonators are being used for sensing biological and chemical entities such as antigens, DNA, protein, viruses, and volatile organic compounds. These miniaturized mass sensors are compact and cost-effective and offer high sensitive and real-time detections. The mass detection in these devices is based on the natural frequency shift after the attachment of the entities. It is well-know that the structural elements exhibit a size dependent mechanical response at the micro- and nanoscales. Therefore, for an accurate detection, it is necessary to account for the size effect in the miniaturized mass sensors.

In this work, we use a well-posed nonlocal elasticity model coupled with a beam theory to study the size dependent free transverse vibration of micro- and nanomechanical mass sensors with arbitrary numbers of attached particles. In order to solve the problem, the sensor is divided into different segments at the cross-sections where the particles are located. The dynamic equilibrium equation of different segments of the sensor and the associated boundary and continuity conditions are derived through the Hamilton principle. The problem is then closed by solving the variationally consistent equations together with a set of higher order constitutive boundary and continuity conditions. Results will be presented on the effect of the size dependency on the frequency shifts and mode shapes, also for higher modes of vibration. It will be revealed that neglecting the size effect in the miniaturized mass sensors may result in wrong detections of the mass and the location of the attached particles.