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Deterministic Microfabrication of Macro-Scale Engineered Materials Based on Lower-Dimensional Subcomponents: Mechanical and Electromagnetic Properties

Mark G. Allen

Professor,
Department of Electrical and Systems Engineering; and Department of Mechanical Engineering and Applied Mechanics, University of Pennsylvania, Philadelphia, PA

ABSTRACT:

The manufacture of materials with bulk volumes and precisely controlled nanostructure has led to the creation of materials with surprising and useful mechanical and electromagnetic properties. Recently we have developed a 'top-down' technique based on sequential electrodeposition, optionally followed by selective etching and infiltration, that allows the creation of highly-structured multilayer materials with precisely designed characteristic lengths in the hundreds of nanometers range, but volumes of manufactured material in the macro range. Such deterministic control of the lower-dimensional characteristic lengths enables the ability to specify the overall macro-scale material properties across multiple domains. The utility of this technique will be discussed in the context of three applications: flexible materials with highly anisotropic mechanical properties; microfabricated permanent magnets with preserved magnetic properties; and magnetic cores which exploit the high permeability, saturation flux density, and thermal conductivity of metallic alloys but possess suppressed eddy current losses in high frequency DC-DC switched power converters.

BIOGRAPHY:

Mark G. Allen received the B.A. degree in chemistry, the B.S.E. degree in chemical engineering, and the B. S.E. degree in electrical engineering from the University of Pennsylvania, Philadelphia, and the S.M. and Ph.D. degrees from Massachusetts Institute of Technology, Cambridge. In 1989 he joined the faculty of the School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, ultimately holding the rank of Regents' Professor and the J.M. Pettit Professorship in Microelectronics, as well as a joint appointment in the School of Chemical and Biomolecular Engineering. In 2013 he left Georgia Tech to become the Alfred Fitler Moore Professor of Electrical and Systems Engineering and Scientific Director of the Singh Nanotechnology Center at the University of Pennsylvania. His research interests are in the development and the application of new micro- and nanofabrication technologies, as well as MEMS. Dr. Allen has held the posts of Editor-in-Chief of the Journal of Micromechanics and Microengineering (JMM), co-chair of the IEEE/ASME MEMS Conference, chair of the Solid State Sensors, Actuators, and Microsystems Conference, and currently serves on the editorial board of both JMM as well as Microsystems and Nanoengineering (Nature Publishing Group). He has co-founded multiple MEMS companies, including Cardiomems, Axion Biosystems, and Enachip. A Fellow of the IEEE, Dr. Allen received the 2016 IEEE Daniel P. Noble Award for contributions to research and development, clinical translation, and commercialization of biomedical microsystems.