

Editorial

Modification, Synthesis, and Analysis of Advanced Materials Using Ion Beam Techniques

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Energetic ion beams are employed for the synthesis, modification, and analysis of advanced, technologically important materials, and many novel applications have emerged over the past several decades. The evolution of the field over this period is recorded in a broad range of conferences that are dedicated to particular aspects of ion-beam modification or analysis of materials, including international conferences on ion beam modification of materials (IBMM), ion beam analysis (IBA), surface modification of materials by ion beams (SMMIB), and so forth. This special issue aims to present some of the latest results in the field.

The special issue contains five review papers covering areas of particular current significance, and nine topical research papers. The review paper by J. C. McCallum et al. presents an overview of single-ion implantation for deterministic doping of semiconductors, with a particular focus on quantum computing and communication. The paper by L. Thome et al. summarizes the current understanding of radiation effects in nuclear ceramics, a topic of direct relevance to the immobilization of radioactive waste and the choice of structural materials for fusion reactors. The paper by K. Grandfield and H. Engqvist reviews the application of focused ion beams (FIBs) in life science, reporting the advances and challenges of FIB techniques in the life sciences, including TEM preparation techniques. The paper by S. P. Dash et al. is dealing with interface and interdiffusion effects

in Co/Si systems using a special high-resolution Rutherford backscattering spectrometer (HRBS). The authors also demonstrate that the Co/Si interdiffusion can be stopped using a thin MgO diffusion barrier layer. The paper by K. Zakrzewska summarizes the properties and defect structure of nonstoichiometric TiO₂ thin films using different ion beam methods.

The topical research papers serve to highlight the diversity and flexibility of ion beam modification and analysis techniques and cover a broad range of material systems and analytical approaches.

The paper of J. Arunkumar et al. addresses the analysis of minor alloying elements in structural reactor materials. The contribution from Z. Li et al. presents the different irradiation properties of nuclear graphite materials with respect to porosity, pore size, and morphology before and after irradiation.

The contribution from Drogowska et al. studies the effect and distribution of hydrogen in Ti/Si, Ti/TiO₂/Si, and Pd/Ti/TiO₂/Si thin-film systems verifying the higher H in-diffusion for systems with Pd top layer. The contribution from H. A. Shukur et al. addresses the morphology, structure, and optical characteristics of irradiated TiO₂ films, demonstrating improved photocatalytic activity of TiO₂ after N⁺ irradiation due to the replacement of O atoms by N atoms.

The paper from L. Meissner et al. reports the biocompatibility of NiTi specimens after high-dose Si, Ti, and Zr implantation revealing the nontoxicity of these materials and associated mesenchymal stem cells (MCS) proliferation.

There are two articles that deal with implantation effects. The first one from K. Baba et al. addresses the doping effects of silver on the structure and properties of diamond-like carbon (DLC), demonstrating improved tribological properties after silver implantation. The second one from R. Machaka et al. presents a systematic study on implantation effects on the mechanical and structural properties in the near-surface region of boron suboxide (B_6O).

Other two papers of this special issue are concerned with technique development and improvement. The first one from J. A. Whitby et al. combines a special time-of-flight secondary ion mass spectrometer (SIMS) with focused ion beam (FIB) and scanning electron microscopy (SEM) to provide information about the roughness of surfaces, and to provide three-dimensional chemical images with a resolution below 50 nm. The contribution from V. Haeublein et al. addresses the issue of ion beam transport and its effect on beam purity and sample contamination using a newly developed simulation tool for modelling the transport mechanisms of ions in the magnet analyser.

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