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Preface

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This special issue of Semiconductor Science and Technology on ‘semiconducting functional oxides’ features 12 peer-reviewed articles. Semiconducting oxides represent a field of topical research. Oxide materials show a vast variety of physical properties—here we set a focus on semiconducting properties that open up the path to novel electronic applications, e.g., as active materials in functional devices.

Overviews are given by three articles: the review article by Bierwagen reports on the state of the art and the perspective on indium oxide for transparent optoelectronic applications. Application of semiconducting functional oxides in devices in thin film transistors (TFTs) is discussed by the review of Kwon and Jeong. It reports on the recent progress in vacuum-based n-type transition metal oxide TFTs. A review of 25 years of pulsed laser deposition of functional oxides in Leipzig is presented by Lorenz et al, showing the rich variety of physical properties ranging from high-$T_c$ superconductors to highly correlated Mott insulators.

Two articles highlight advances in growth and fabrication methods: the effect of indium as a surfactant in $(Ga_{1-x}In_x)_2O_3$ epitaxial growth on $\beta$-Ga$_2$O$_3$ is discussed for metal organic vapour phase epitaxy in the article by Baldini et al. Here, the aim is to obtain layers with very high crystal quality. The authors show how the concentration of structural defects, such as stacking faults and twins, was decreased dramatically. Keeping the effects on the environment low is one of the feature points of the new method presented in the article by Branquinho et al on solution-based ZTO/AlO$_x$ TFTs. Such layers are considered as a viable option for low-cost flexible electronics.

Doping is of most importance for applications of semiconducting functional oxides in electronic devices. The article by Lavrov et al discusses the identification via Fano resonances in photoconductivity spectra of hydrogen donors in ZnO and rutile TiO$_2$. In the article by Korhonen et al cation vacancies and the electrical compensation in Sb-doped thin-film SnO$_2$ and ZnO are investigated by positron annihilation. It shows that at high doping levels cation vacancy defects dominate the positron annihilation signal. These defects, when at sufficient concentrations, can efficiently compensate the n-type doping produced by Sb. The authors discuss the case in ZnO versus that in SnO$_2$ in which the concentrations appear too low to cause significant compensation. In the article by Schirmer et al a theoretical investigation is presented on the coexistence of localized and extended acceptor states in high gap semiconductors, and they discuss the electronic structure calculations of small polarons. More theoretical studies are presented in the article by Varley and Schleife, with Bethe–Salpeter calculation of optical-absorption spectra of In$_2$O$_3$ and Ga$_2$O$_3$. These investigations are important as currently no experimental data is available, for instance, for the dielectric functions across a large photon–energy range. And, firstly the temperature-dependent thermal conductivity is measured and discussed in detail with respect to doping in Mg-doped and undoped $\beta$-Ga$_2$O$_3$ bulk-crystals in the article by Handwerg et al.

Electrical contacts and device properties are most crucial to the transfer of an interesting electronic material to application. In the article by Elzwawi et al the effect of Schottky gate type and channel defects on the stability of transparent ZnO...
metal-semiconductor field-effect transistors is studied. Device instability appeared to be strongly dependent on gate metal type, bias conditions and ZnO film morphology. Similarly, structural and optical properties of (In,Ga)2O3 thin films and characteristics of Schottky contacts thereon are investigated in detail in the article by von Wenckstern et al. The importance of the charge injection layer for high-permittivity dielectrics is discussed in the article by Hillmann et al. Here, ultimate growth control is achieved by the application of atomic layer deposited Al2O3 as barrier material.

We present this selection of articles to show current developments and open issues in this rapidly developing field and hope that readers enjoy it and pick up scientific ideas for their advances in research and technology of semiconducting functional oxides.