# DS 46: Ion and Electron Beam Induced Processes

Time: Friday 9:30–11:00 Location: CHE 89

DS 46.1 Fri 9:30 CHE 89

**Tuning of magnetic and structural properties of $Fe_{60}Al_{40}$ thin films by ion irradiation** — •Jonathan Ehrler[1,2], Rantej Bali[1], Roman Böttger[1], Jörg Grenzer[1], and Kay Potzger[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstrasse 400, 01328 Dresden, Germany — [2]Dresden University of Technology, Helmholtzstrasse 10, 01069 Dresden, Germany

The effects of ion implantation on the structural and magnetic properties of $Fe_{60}Al_{40}$ films, possessing A2 and B2 structure respectively, have been investigated by means of X-ray diffraction and Vibrating sample magnetometry. The studies show that the magnetic properties of the 250 nm thick $Fe_{60}Al_{40}$ films depend on the structural order only. The chemical disorder induced evolution of ferromagnetism comes along with an abrupt disappearance of the (100)-superlattice peak.

The irradiation of paramagnetic B2 $Fe_{60}Al_{40}$ with $H^+$, $He^+$ or $Ne^+$ ions with different fluences at low temperatures led to an increase of saturation magnetization ($M_S$) going along with a lattice expansion induced by structural disorder. This effect did not appear for proton irradiation at elevated temperatures (250 °C) where the ordered B2 phase was retained. Upon low temperature hydrogen implantation of disordered A2 $Fe_{60}Al_{40}$ films, on the other hand, unlike for helium or neon irradiation, the lattice parameter and $M_S$ decreased indicating a little ordering. This might offer the possibility of $H^+$ irradiation induced ordering of chemically disordered alloy thin films well below the ordering temperature.

DS 46.2 Fri 9:45 CHE 89

**Material processing via ion beam treatment** — •Martin Becker, Angelika Polity, and Peter J. Klar — Institute of Experimental Physics I, Justus Liebig University Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany

In order to deposit polycrystalline thin films on different substrates, sputtering methods are the most established techniques. This broad acceptance is due to the homogeneity and reproducibility of the grown layers with high deposition rates. Conventional RF and DC sputtering, however, are subject to limitations based on substrate heating and volatile impurities to be incorporated into the growing films, both issues being significantly reduced in ion beam sputter deposition (IBSD). Films with high crystalline quality can be produced with an independent control of ion energy, beam direction and current density.

We report on the development of a system for the ion beam processing of semiconductors. In order to deposit thin layers of desired material by IBSD as well as to modify their properties by prior or simultaneous ion beam treatments, different sputter geometries come into play, whose discussion will be part of this presentation. An optimization of the crystalline and optical properties is carried out for oxide-based materials. In addition to binary materials, the advantages of forming ternary materials via dual source operation are discussed. On this basis, composition gradients were produced. Within this framework, self-designed ion sources are characterized according to the requirements of different material science processes.

DS 46.3 Fri 10:00 CHE 89

**Ultrafast electronic response of graphene to a strong and localized electric field** — •Richard A. Wilhelm[1], Elisabeth Gruber[2], Rémi Pétuya[3], Roland Kozubek[4], Bernhard C. Bayer[5], Anke Hierzenberger[4], Valerie Smejkal[2], Florian Libisch[2], Iñigo Adalzabal[7], Andrey K. Kazansky[3,8], Arkady Krasheninnikov[1], Marika Schleberger[4], Stefan Facsko[1], Andrei G. Borisov[6], Andres Arnau[3,7], and Friedrich Aumayr[2] — [1]HZDR — [2]TU Wien — [3]DIPC, San Sebastian — [4]Uni Duisburg-Essen — [5]Uni Wien — [6]CNRS, Paris — [7]CFM, San Sebastian — [8]IKERBASQUE, Bilbao

Ion transmission through thin solid films revealed many interesting properties of ion-solid interaction mechanisms, among them is ion equilibrium charge state and the ion stopping force. Using a well defined target such as free-standing graphene, ion transmission can also provide insights into processes occuring in the target material. Here we use slow highly charged ions and inverstigate their charge exchange and energy loss due to transmission through graphene. In a joint theoretical and experimental effort we find that large current densities of at least $10^{12}$ A/cm$^{-2}$ are sustained by graphene without rupture, even though this current is only active for a few femtoseconds on a nm$^2$ sized area, it's value is about 3 orders of magnitude higher than established DC breakdown current densities. Our study shows that especially highly charged ions are well suited to investigate material properties under extreme conditions on a femtosecond time scale.

DS 46.4 Fri 10:15 CHE 89

**Epitaxial nitride thin films by ion mass and ion energy selective ion-beam assisted deposition** — •Philipp Schumacher[1], Michael Mensing[1], Jürgen W. Gerlach[1], Stephan Rauschenbach[2], and Bernd Rauschenbach[1,3] — [1]Leibniz-Institut für Oberflächenmodifizierung, 04318 Leipzig — [2]Max-Planck-Institut für Festkörperforschung, 70569 Stuttgart — [3]Fakultät für Physik und Geowissenschaften, 04103 Leipzig

Ion-beam assisted deposition (IBAD) is a versatile tool for the synthesis of thin films, as it offers several degrees of freedom to modify the properties of the fabricated material. Ion sources for IBAD typically provide a blend of ion species with broad distributions of ion kinetic energy in the ion beam. For a fundamental understanding of ion-assisted growth processes, however, it is required to evaluate the influence of ion mass and ion kinetic energy, separately. In this contribution, first a novel setup for hyperthermal IBAD of GaN including a dedicated quadrupole mass filter is presented. The deposition of the model material GaN using only one ion species ($N^+$ or $N_2^+$) while independently defining the ion kinetic energy is accomplished. Second, results on GaN thin films synthesized by ion mass and ion energy selective IBAD on both 6H-SiC(0001) and $Al_2O_3$(1-102) substrates are presented. Atomic force microscopy is applied to analyze the surface topography. The thin films are shown to be epitaxial as determined by reflection high-energy electron diffraction and x-ray diffraction. The properties of the deposited thin films are compared with respect to the utilized separated parameters.

DS 46.5 Fri 10:30 CHE 89

**Ion Induced Surface Pattern Formation by ion implantation** — •Hans Hofsäss, Kun Zhang, and Omar Bobes — Fakultät für Physik, Universität Göttingen, Göttingen, Germany

Recently Bradley and Hofsäss introduced ion implantation as an additional effect contributing to pattern formation. The theory is briefly introduced and the calculation of implantation curvature coefficients, based on the linear continuum models for pattern formation and the crater function formalism are described. The calculations use Monte Carlo simulations, taking into account contributions due to erosion, implantation, recoil redistribution and the dynamic layer thickness effect. We are now able to quantitatively predict pattern formation or surface stability for a variety of ion-target systems and a broad range of irradiation conditions. Pattern formation on a-C surfaces by $C^+$ and $Ne^+$ ion irradiation as well as $N^+$ ion irradiation of Si and $Si_3N_4$ demonstrate that ion implantation can be crucial for pattern formation.

DS 46.6 Fri 10:45 CHE 89

**Chemical Diffusion of Potassium Ions in thin film PrMnO3** — •Karl-Michael Weitzel[1], Johannes Martin[1], Melanie Gräf[1], Thilo Kramer[2], and Christian Jooss[2] — [1]Philipps-Universität Marburg — [2]Universität Göttingen

The transport of potassium through praseodymium-manganese oxide (PrMnO3) has been investigated by means of the bombardment induced ion transport (BIIT) technique. To this end potassium ions are attached to the front side of a 250 nm thick sample of PrMnO3. Most of the potassium ions become neutralized at the surface of the PrMnO3. Part of the potassium ions diffuse through the PrMnO3. Ex situ analysis of the sample by time-of-flight secondary ion mass spectrometry (ToF-SIMS) reveals pronounced concentration profiles of the potassium indicative of chemical diffusion. Two distinctly different diffusion coefficients have been derived, i. one assigned to bulk diffusion and ii. another one assigned to diffusion along grain boundaries. The latter conclusion is supported by transmission electron microscopy of thin lamella cut out from the sample which reveals twin grain boundaries reaching through the entire sample.