HL 28: Diamond II (joint session KFM/HL)

This session represents the physics, the production and applications of diamond and diamond related materials in the fields of dielectrics, electronics, high frequency techniques, GHz * THz * applications, mechanics and optics and biological applications as well. Defects in diamond have a large influence to the physical properties (e. g. NV-centers). Applications of diamond (single, poly-crystalline, UNCD, etc.) or related materials in technical systems are part of this session (Nuclear fusion applications, high frequency heating systems and material processing).

Chair: Theo Scherer (KIT)

Time: Wednesday 9:30–11:30 Location: PHY 5.0.20

HL 28.1 Wed 9:30 PHY 5.0.20

Antibacterial propensities of UNCD with embedded silver nanodroplets — •Daniel Merker[1], Blagovesta Popova[2], Tobias Weingärtner[3], Thomas Bergfeldt[3], Gerhard Braus[2], Johann Peter Reithmaier[1], and Cyril Popov[1] — [1]Institute of Nanostructure Technologies and Analytics, Universität Kassel, Kassel, Germany — [2]Institute for Microbiology and Genetics, Universität Göttingen, Göttingen, Germany — [3]Institute of Applied Materials - Applied Materials Physics, Karlsruher Institut für Technologie, Eggenstein-Leopoldshafen, Germany

Thin diamond films are considered a promising material for coating of implants due to the mechanical and chemical durability in combination with biological compatibility. These properties are utilized to increase the lifetime and support the tissue integration of the implant. In this work we address another issue for implantation surgery, namely the danger of a bacterial infection. We prepared ultrananocrystalline diamond (UNCD) films with embedded silver nanodroplets to utilize the well-known antibacterial effect of silver ions. The changes in the morphology of the Ag nanodroplets depending on the conditions for their preparation was investigated by SEM and AFM and afterwards the composition of the resulting UNCD/Ag/UNCD layers was revealed by AES. The thickness of the capping UNCD layer can provide a control mechanism for the silver release. Therefore, we prepared samples with different capping layer thicknesses and investigated the amount of the released Ag into water with ICP-MS. Finally, we tested the layers against two bacteria: E. coli and B. subtilis.

HL 28.2 Wed 9:50 PHY 5.0.20

Fabrication of Photonic Crystals Based on Planarized Nanocrystalline Diamond Films — •Julia Heupel, Johann Peter Reithmaier, and Cyril Popov — Institute of Nanostructure Technologies and Analytics, Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany

Utilizing nanocrystalline diamond (NCD) membranes deposited on silicon dioxide/silicon substrates, two-dimensional photonic crystal slabs were fabricated. For adjusting the NCD film thickness as well as for smoothening the intrinsically rough surface, a planarization process was developed and investigated regarding the NCD surface roughness and overall thickness reduction. This procedure comprises the application and polymerization of spin-on glass (SOG), forming an even surface layer on NCD, followed by an inductively coupled plasma reactive ion etching (ICP RIE) step. The photonic crystal structures were prepared in NCD samples with a planarized surface by means of electron beam lithography (EBL) and ICP RIE. By underetching of the sacrificial silicon dioxide layer with a hydrofluoric acid solution, the photonic crystals were made suspended in air. The effect of the variation of the exposure dose factors on the air hole diameter and shape in the photonic hexagonal lattice was examined. Different established recipes for dry etching of the silicon dioxide hard mask were studied and analyzed.

HL 28.3 Wed 10:10 PHY 5.0.20

Improving magnetic nanoimaging using diamond-AFM-tips containing NV centers — •Arne Götze, Christoph Schreyvogel, Christian Giese, Claudia Widmann, Christoph Nebel, and Oliver Ambacher — Fraunhofer Institut für angewandte Festkörperphysik, Tullastraße 72, 79108 Freiburg, Germany

The fabrication of microelectronic components is approaching its physical limits. The gate length of modern transistors is now below 10 nm. Further miniaturization could lead to a reduction in costs and energy consumption, but as the devices become smaller the failure rate during production increases. Diamond-AFM-tips containing single NV centers that enable the imaging of the magnetic field strength with high sensitivity and spatial resolution even at room temperature will help uncover the reasons for this.

The focus of our work is to improve the performance of the NV-tips by producing diamond with high crystal quality and single NV centers. One goal is to create single NV centers close to the surface of the tip during CVD diamond growth by coating microstructured diamond tips with a thin layer of N-doped diamond. This will lead to longer spin coherence times and improved sensitivity compared to N-implantation. In order to better understand the N-doping and NV-formation processes we study the tips by using a confocal microscope and measuring 3D photoluminescence distributions. With this knowledge we are able to tailor the CVD processes and improve the measurement capabilities of magnetic imaging using diamond-AFM-tips.

Break 20 min

HL 28.4 Wed 10:50 PHY 5.0.20

High nitrogen doping of CVD-diamond — •Julia Langer[1], Volker Cimalla[1], Verena Zürbig[1], Jan Jeske[1], Tim Eichhorn[2], Brett Johnson[3], Lutz Kirste[1], Christoph Schreyvogel[1], Arne Götze[1], and Oliver Ambacher[1] — [1]Fraunhofer Institute for Applied Solid State Physics, Tullastraße 72, 79108 Freiburg — [2]NVision Imaging Technologies GmbH, Albert-Einstein-Allee 11, 89081 Ulm, Germany — [3]The University of Melbourne, Victoria 3010, Australia

Nitrogen-vacancy centers in diamond are studied extensively over the past decades. Their properties as quantum system feature a wide range of applicability. A new approach is the growth of high nitrogen doped CVD-diamond to create ensembles of nitrogen-vacancy centers for the purpose of measuring sensitive magnetic fields by laser threshold magnetometry. The challenge arises from keeping detrimental material effects low such as absorption and the incorporation of other magnetic moments. Within this study we investigate the nitrogen incorporation in CVD-diamond depending on nitrogen flow and growth rates. A comparison of growth series with different crystallographic oriented substrates shows new insight in the varying dependencies.

HL 28.5 Wed 11:10 PHY 5.0.20

Thermoelectric generator made of tailored carbon allotropes — •Rudolf Borchardt, Timo Fromm, and Stefan Rosiwal — Chair of Materials Science and Engineering for Metals, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

A thermoelectric generator (TEG) can be used to recover energy by the conversion of waste heat into electricity. Therefore such generators use thermoelectric materials that directly generate electrical power from a temperature difference, without any moving parts. However common thermoelectric materials suffer from rarity, are toxic or are not temperature stable for a long time. Our aim is to develop new thermoelectric materials with good availability base on carbon allotropes. Here we show a TEG made out of three different kinds of carbon allotropes: micro crystalline diamond for fast thermal transport, as well as p-type nano crystalline diamond and n-type graphene nanowalls as the active materials for the energy conversion. The materials were produced as freestanding foils by chemical vapor deposition (CVD), and laser cut pieces of the foils were brazed with an active silver-titanium solder to fabricate the TEG. This TEG was tested up to a temperature difference of 200 K, resulting in an open circuit voltage of over 120 mV and an output power of 118 μW.