HL 16: Diamond

Time: Monday 16:00–17:30 Location: H13

HL 16.1 Mon 16:00 H13

Improved generation of single nitrogen-vacancy centers in diamond by ion implantation — •Boris Naydenov[1], Vladimir Richter[2], Johannes Beck[1], Matthias Steiner[1], Gopalakrishnan Balasubramanian[1], Jocelyn Achard[3], Fedor Jelezko[1], Jörg Wrachtrup[1], and Rafi Kalish[2] — [1]3 Institute of Physics, University of Stuttgart, Stuttgart Germany — [2]Solid State Institute, Technion City, Haifa Israel — [3]Laboratoire d'Ingénieurie des Matériaux et des Hautes Pressions, CNRS, F-93430 Villetaneuse, France

Nitrogen-vacancy (NV) centers in diamond have recently attracted the attention of many research groups due to their possible application as quantum bits (qubits), ultra low magnetic field sensors and single photon sources. These color centers can be produced by nitrogen ion implantation, although the yield is usually below 5 % at low ion energies. Here we report an increase of the NV production efficiency by subsequently implanting carbon ions in the area of implanted nitrogen ions. This method improves the production yield by more than 50 %. We also show that very low nitrogen concentration (below 0.1 ppb) in diamond can be determined by converting the intrinsic nitrogen atoms to single NV centers and detecting the latter using a confocal microscope.

HL 16.2 Mon 16:15 H13

Creation of nitrogen-vacancy centres in diamond with high resolution — •Sébastien Pezzagna[1], Dominik Wildanger[2], Stefan W Hell[2], Paul Mazarov[3], Andreas D Wieck[3], Boris Naydenov[4], Fedor Jelezko[4], Jörg Wrachtrup[4], and Jan Meijer[1] — [1]Rubion, Ruhr-Universität Bochum, Bochum, Germany — [2]Department of NanoBiophotonics, Max Planck Institute for Biophysical Chemistry, Göttingen, Germany — [3]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, Bochum, Germany — [4]3rd Institute of Physics, University of Stuttgart, Stuttgart, Germany

Nowadays, diamond and the nitrogen-vacancy (NV) colour centres constitute the best solid-state system in view of quantum-computing applications [1]. It has also been shown recently that single NV centres could be used as nanoscale magnetic sensors [2]. Such applications require the creation of single NV centres with very high resolution and with a high efficiency. The nano-implanter at the university of Bochum provides low energy nitrogen ions which can be implanted through a hole pierced in the tip of an atomic force microscope [3]. Ultrapure diamond samples have been implanted with spot sizes of 50nm and less. Stimulated Emission Depletion (STED) microscopy [4] has been used to characterise and resolve the implanted spots.

[1] M. V. Gurudev Dutt et al., Science 316, 1312 (2007).
[2] G. Balasubramanian et al., Nature 455, 648 (2008).
[3] J. Meijer et al., Appl. Phys. A 91, 567 (2008).
[4] E. Rittweger et al., Nature Photonics 3, 144 (2009).

HL 16.3 Mon 16:30 H13

Nanoscale electric field sensing with a single spin in diamond — •Florian Dolde[1], Tobias Nöbauer[2], Boris Naydenov[1], Helmut Rathgen[1], Fedor Jelezko[1], and Jörg Wrachtrup[1] — [1]3. Physikalische Institut Universität Stuttgart,Stuttgart,Deutschland — [2]Atominstitut österreichischer Universitäten TU Wien, Wien, Austria

We study the linear stark effect of a single nitrogen vacancy center in diamond (NV). The unique properties of the NV allow optical detection of magnetic resonance (ODMR). We use the spin of a single NV as a nano scale electric field sensor. Using pulsed experiments long coherence times are reached, such that the phase difference induced by an alternating electric field can be detected. We reached shot noise limited detection of the electric field. The nano scale sensing of electric fields has a wide range of applications in biology and material sciences.

HL 16.4 Mon 16:45 H13

Oberflächenwachstumskinetik ultrananokristallener Diamantschichten — •Hadwig Sternschulte[1], Claudia Baier[2], Sliman Ghodbane[3], Martin Fischer[4], Doris Steinmüller-Nethl[3], Matthias Schreck[4] und Ulrich Stimming[1] — [1]nanoTUM, TU München, James-Franck-Str. 1, D-85748 Garching — [2]Physik Department E19, TU München, D-85748 Garching — [3]rho-Best coating GmbH, Exlgasse 20a, A-6020 Innsbruck — [4]Institut für Physik, Universität Augsburg, D-86135 Augsburg

Ultrananokristalline Diamantschichten (UNCD) zeichnen sich durch ihre kleine, von der Schichtdicke unabhängige Korngröße von 10 nm und weniger sowie von Rauhigkeitswerten von 10-15 nm aus. Die runden, kristallinen Diamantkörner sind in einer sp^2/sp^3-Matrix ohne Vorzugsorientierung eingebettet. Proben mit solchen Eigenschaften stellen ideale Systeme dar, um dasWachstum und die Oberflächenentwicklung mit bestehenden Modellen zu vergleichen. Die ultrananokristallinen Diamantschichten wurden mit Hilfe eines hot-filament-Verfahrens in einem H_2/CH_4-Gasgemisch auf Siliziumsubstraten abgeschieden. Durch eine Variation der Bekeimungsparameter wurde die Primärnukleationsdichte zwischen $10^8/cm^2$ - $10^{10}/cm^2$ eingestellt. Die Wachstumsdauer betrug zwischen 5 und 80 min. Zur Bestimmung der Oberflächenwachstumskinetik wurden diese UNCD-Schichten mit Rasterelektronen- und Rasterkraftmikroskopie charakterisiert. Die zeitliche Entwicklung der Größe einzelner Diamantinseln, die Wachstumsrate und der Rauhigkeit in Abhängigkeit der Primärnukleationsdichte wird diskutiert und mit Simulationsrechnungen verglichen.

HL 16.5 Mon 17:00 H13

Noise characterization of diamond solution gate field effect transistors for biosensing applications — •Moritz Hauf, Lucas Hess, Martin Stutzmann, and José A. Garrido — Walter Schottky Institut, Technische Universität München, 85748 Garching, Germany

Diamond, when terminated with hydrogen at the surface, shows the intriguing property of a p-type surface conductivity with a two-dimensional hole gas forming beneath the surface. If brought into electrolyte solutions, this surface conductivity can be effectively modulated by an electrode controlling the electrolyte potential. This allows for the fabrication of FETs with the electrolyte solution functioning as the gate, therefore called solution gate FETs. SGFETs show great potential for biosensing and biomedical applications due to the operation in aqueous environment. In particular, diamond is considered a suitable material due to its good biocompatibility and electrochemical inertness.

We have shown that such diamond SGFETs are capable of extracellular recording of action potentials from different cell types. For future applications, it will be highly important to have a low noise level of the SGFET for the chemical detection of single neurotransmitter vesicles. For comparison of device performance we report on the noise of SGFETs realized with different substrate materials such as diamond, graphene, Si, and GaN. For diamond, we compare different surface properties such as surface roughness or dislocation density of the diamond crystal that can contribute to the noise level.

HL 16.6 Mon 17:15 H13

Spatially resolved photoconductance of oxygen barriers on hydrogenated single crystalline diamond — •Max Seifert, Markus Stallhofer, Moritz Hauf, Gerhard Abstreiter, José A. Garrido, and Alexander W. Holleitner — Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching, Germany

Undoped single crystalline hydrogen-terminated diamond exhibits a p-type surface conductivity. This surface conductivity originates from a two dimensional hole gas formed due to a band bending beneath the surface. An oxygen-terminated diamond surface, however, shows no surface conductivity and therefore, thin lines with oxygen-termination can be used to form tunneling barriers within the two dimensional hole gas. We create such barriers with a lithographic width down to 50 nm by electron-beam lithography. In spatially resolved photocurrent measurements, we demonstrate that the devices can be exploited for photodetector applications at room temperature.