DS 1: Focus: Diamond Technology and Electronics (joint session KFM/DS/HL)

Time: Monday 9:30–11:40 Location: HSZ 105

Invited Talk DS 1.1 Mon 9:30 HSZ 105

Doped CVD diamond layers for electronic device applications: Experimental and theoretical study — •Ken Haenen — Institute for Materials Research (IMO), Hasselt University, Diepenbeek, Belgium — IMOMEC, IMEC vzw, Diepenbeek, Belgium

While diamond is considered to be the ultimate wide band gap semiconductor due to its combination of superlative properties, the full understanding of the connection between growth conditions and subsequent layer properties is still lacking. In this presentation, focus is first devoted to the deposition of heavily and lightly B-doped CVD diamond films. Employing microwave plasma enhanced CVD in combination with Ib (100)-oriented high pressure high temperature (HPHT) substrates, the influence of the [C]/[H] ratio on key material properties is presented. This includes the surface morphology, crystal quality, and electrical transport properties by employing a wide range of characterization techniques, i.e.. Hall effect in a wide temperature range, FTIR spectroscopy, Raman spectroscopy, X-ray absorption spectroscopy, XPS, AFM, optical microscopy, and transmission electron microscopy. First principles density functional calculations (DFT) were performed to model the interaction of B with the H-terminated diamond surface, corroborating the observed increase of B-doping incorporation with used methane concentration. The insight offered by the combination of experiment and theory clearly provides a pathway to more efficient doping and enhanced crystal quality. Finally, the use of said layers in Schottky barrier diodes is presented.

Invited Talk DS 1.2 Mon 10:00 HSZ 105

Research and development for fabrication of diamond wafers for industrial use — •Hideaki Yamada — AIST, Osaka, Japan

Figure of merits of diamond as a candidate material in power electronics are superior to those of other materials, such as Si, SiC, and GaN. Especially, recent increase of the power density in power devices for high-frequency use require extremely high thermal conductivity of diamond. On the other hand, because of its stable quantum state under the standard condition, variety of sensors with wide dynamic-range and quantum computing have been studied. Therefore, in addition to its mechanical and optical applications, use of diamond in spintronics as well as electronics have been attracted researchers for variety of future applications in industry. One of the bottle necks for realization of them is in technique to fabricate diamond wafers with large area and sufficient quality under acceptable cost. We have developed techniques to enlarge seed substrates, and process them to wafers. To understand mechanism of the crystal growth, we simulated the growth environment numerically and compared them with experimental results. Our recent trials, achievement and future prospective to solve above issues aiming at realization of the industrial use of diamond will be presented with the related current state-of-the-art.

20 min. break

Invited Talk DS 1.3 Mon 10:50 HSZ 105

Diamond: Material of the future for high power, high frequency devices and quantum applications — •Shannon Nicley — Department of Materials, University of Oxford, Oxford, UK

Diamond is an exceptional material in many ways, not only for its well known hardness and highest room temperature conductivity, but also electronic properties like high electron and hole mobilities and a high electronic breakdown field strength. These properties predict that diamond electronic devices should have superior high power and high frequency performance over other semiconductor materials. Diamond is also a promising solid-state host for atomic scale defects for quantum applications. The realisation of diamond electronic devices and the full implementation of diamond quantum applications have both been limited in part by our ability to reliably grow high quality single crystal diamond. Control over the incorporation of dopant atoms such as boron and phosphorus is key for high power applications, and the ability to grow high purity, low-strain diamond as well as precisely place quantum defects remain areas of active investigation. I will give an overview of the growth of synthetic diamond and review recent progress in the control of boron and phosphorus doping. I will also present a very recently developed method for the deterministic and accurate placement of optically coherent NV centres using a laser writing technique. I will discuss the challenges in this field and give an outlook for both extreme electronic device and quantum applications.

DS 1.4 Mon 11:20 HSZ 105

Preliminary study of diamond based Kinetic Inductance Detectors — •Francesco Mazzocchi, Dirk Strauss, and Theo Andreas Scherer — Karlsruhe Institute of Technology (IAM-AWP), Hermann Von Helmholtz Platz 1, 76344 Eggenstein-Leopoldshafen

Kinetic Inductance Detectors (KIDs) have proven themselves as a very versatile cryogenic detector technology capable of applications in various fields due to their flexibility of design, sensibility and ease of production. We have recently proposed a polarization sensitive Lumped Elements KID as sensor for an innovative polarimetric diagnostics based on quantum cascade lasers (QCL) for application in the nuclear fusion. Each detector unit is composed by 4 pixels arranged at the vertices of a square, each pixels being sensible to only one polarization direction. The current system is based on niobium nitride (NbN) superconductor over High Resistivity Silicon (HRSi) substrate. Such material delivers good performances but its relatively high dielectric constant and loss tangent lead to increased substrate losses. Using a transparent substrate may improve this aspect and also the radiation resistance of such devices. Diamond is the substrate of choice, being a material already widely studied and used in the fusion environment as high power microwave window, due its outstanding optical and mechanical performances. In this work we present the preliminary design study and simulations for a diamond based Kinetic Inductance Detector with both single and poly-crystalline diamond (SCD/PCD) substrates taken into account.