KFM 6: Diamond

Time: Tuesday 9:30–11:50 Location: TOE 317

KFM 6.1 Tue 9:30 TOE 317

ECRH systems for nuclear fusion reactors — •Dirk Strauss, Theo Scherer, Sabine Schreck, Peter Späh, Andreas Meier, and Gaetano Aiello — Karlsruher Institut für Technologie KIT-IAM-AWP ; D-76344 Eggenstein-Leopoldshafen

A typical ECRH system in fusion devices includes gyrotrons as millimeter wave beam sources, transmission lines with a diamond window as confinement barrier and antennas to inject the beam into the plasma. The electron-cyclotron resonance condition at the required position can be achieved by angular steering or frequency tuning. Apart from heating and current profile shaping the small wavelength allows to suppress MHD instabilities as neoclassical tearing modes. The state of the art ECRH is presented and different variants are discussed with a focus on ultra-low-loss CVD diamond windows.

KFM 6.2 Tue 9:50 TOE 317

Application of CVD Diamond disks for ECRH systems of fusion reactors — •Sabine Schreck, Gaetano Aiello, Andreas Meier, Theo Scherer, and Dirk Strauss — Karlsruhe Institute of Technology, Institute for Applied Materials, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany ,

In fusion reactors, Electron Cyclotron Heating and Current Drive (EC H&CD) systems are used for plasma heating and stabilization. Key components of these systems are diamond windows, which consist of a chemical vapor deposition (CVD) diamond disk (p.c.) joined into a metallic housing. Such windows, employed as gyrotron- or torus windows, allow transmission of high power microwave beams and serve as vacuum boundaries. A very low dielectric loss and a sufficient mechanical stability is thus required.

The ITER EC torus window consists of a diamond disk with a diameter of about 70 mm and a thickness of 1.11 mm (resonance thickness for 170 GHz). The window serves also as confinement barrier for tritium and is classified as "Protection Important Component". A specific test program is required for its qualification, including prototypical activities.

For future fusion machines like DEMO, most likely broadband window solutions as the double disk window or the Brewster window will come into operations. This implies also new requirements for the disks, e.g. large diameters of minimum 180mm for the inclined Brewster-angle disk for a typical aperture of 63.5 mm.

KFM 6.3 Tue 10:10 TOE 317

MPA CVD diamond in nuclear fusion: dielectric characterization and influence of defects — •Gaetano Aiello, Theo Scherer, Andreas Meier, Sabine Schreck, and Dirk Strauss — Karlsruhe Institute of Technology, Institute for Applied Materials, D-76021 Karlsruhe, Germany

Microwave Plasma Assisted (MPA) Chemical Vapour Deposition (CVD) diamond is used as window material in the shape of a disk in the heating and diagnostic systems for fusion reactors due to its combination of extraordinary thermal, mechanical and optical properties. CVD diamond polycrystalline disks with central loss tangent lower than 2E-05 allow for transmission of high power microwave beams (1-2 MW). However, the effect on the dielectric losses in diamond of defects like dislocations and nitrogen-vacancy centers introduced by the growing process and/or by subsequent neutrons and gammas irradiation has not fully investigated and understood so far. Investigations by several spectroscopic methods on non-irradiated and irradiated diamond samples are thus planned. In particular, first Elastic Recoil Detection Analysis (ERDA) measurements of small diamond samples have been carried out at the Tandem Laboratory in Uppsala, Sweden, aiming to calculate the sample composition with major focus on nitrogen content. The nitrogen plays an important role in the CVD process as it allows faster growth rates, but it causes greater dielectric losses in diamond.

20 min. break

KFM 6.4 Tue 10:50 TOE 317

Fabrication of Thin Monocrystalline Diamond Membranes — •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

Due to its exceptional physical and chemical characteristics, diamond in a form of thin membranes is a particularly promising material for the fabrication of high quality photonic devices with envisioned applications in quantum information technologies (QIT). In this work we report on the structuring process of thin monocrystalline diamond (MCD) membranes, with a thickness of a few microns and rms roughness values in the range of 0.5-0.6 nm (on a 5 x 5 μm area), by means of inductively coupled plasma reactive ion etching (ICP RIE). A diamond bulk mask was utilized as an etch mask during the fabrication, featuring distinct hole diameters with angled sidewalls to avoid trenches and cracks at the edges of the membrane. Besides an examination of different mask diameters on the resulting morphology and etch quality of the membranes, differing etching mixtures and arrangements were tested to minimize the micro-masking, which can lead to pit structures and hence to an enhanced roughness of the membrane.

KFM 6.5 Tue 11:10 TOE 317

Immobilization of Proteins on Ultrananocrystalline Diamond Surfaces — •Daniel Merker[1], Daniela Bertinetti[2], Katrin Schröder[3], Monika Stengl[3], Friedrich Herberg[2], Johann Peter Reithmaier[1], and Cyril Popov[1] — [1]Institute of Nanostructure Technologies and Analytics, Universität Kassel, Deutschland — [2]Department of Biochemistry, Universität Kassel, Deutschland — [3]Department of Animal Physiology, Universität Kassel, Deutschland

To investigate the molecular mechanisms of the inner clock in the madeira cockroach the detection of coupling factors is required. These coupling factors are secreted neuropeptides and neurotransmitters necessary to synchronize clock neurons into ensembles which direct the circadian rhythm. In this work we study the possible application of UNCD as a substrate for antibody immobilization to detect these coupling factors. Initially, various covalent coupling routes were investigated to immobilize the green fluorescent protein (GFP). Besides coupling chemistry with functional groups introduced directly on the UNCD surface by plasma, photochemical grafting on H-terminated as-grown UNCD was also investigated. The covalent coupling did not work since the functional groups on the UNCD surface were not reactive enough. In contrast, the photochemical grafting showed successful immobilization of GFP on surfaces with patterned modification (H-terminated squares on O-terminated surface). Since the O-terminated UNCD films have been already successfully applied for long-term cultivation of clock neurons we aim to utilize UNCD as antibody platform and to realize a time-resolved detection of coupling factors.

KFM 6.6 Tue 11:30 TOE 317

Physics of natural and artificial diamond gemstones — •Theo Andreas Scherer — KIT-IAM-AWP, Hermann-von-Helmholtz-Platz 1, D-76344 Eggenstein-Leopoldshafen

Diamond gemstones were very well appreciated in the antique world. Independent on the purpose of jewelry, diamond is a crystalline solid state material with excellent physical and chemical properties as a high Young modulus or a very high thermal conductivity. By doping the material with boron, electrical conductivity can be observed. This is important for electronic devices. In this talk the wide range of production of gemstones and technical applications like high frequency high power microwave transmission diamond windows for nuclear fusion power plants will be presented. Different diamond classifications, cuts and colors by impurities will be shown. A comparison of natural diamonds and artificial produces ones are topic of the discussion.