DS 20: Application of thin films

Time: Wednesday 9:30–11:30 Location: H 0111

DS 20.1 Wed 9:30 H 0111

Towards attosecond pulse shaping in the water window — •Alexander Guggenmos[1,2], Michael Hofstetter[1,2], Ferenc Krausz[1,2], and Ulf Kleineberg[1,2] — [1]Fakultät für Physik, Ludwig-Maximilians-Universität München, Garching, Germany — [2]Max-Planck-Institut für Quantenoptik, Garching, Germany

Attosecond pulses pave the way towards the direct observation of electron dynamics in atoms, molecules or solid surfaces/nanostructures with a never before achieved temporal precision. Having the tunability for shaping these generated pulses from high harmonic radiation, serves as key for getting even deeper physical insight into these dynamics utilizing pump-probe experiments. Aperiodic broadband multilayer XUV mirrors are key components to fulfill these requirements and to offer for each experiment its perfectly tailored attosecond pulse due to controlling spectral resolution, center energy, temporal resolution or to compress chirped pulses to their fourier limit. Extending the current technology to the water window range around 300-500 eV may enable on the one hand a complete new sort of experiments as the in-vitro investigation of bio-materials on the attosecond time scale but on the other hand limits the scope for perfectly matched pulses due to fabrication limits of aperiodic multilayer designs.

We will present first investigations of multilayer XUV optics for the water window range which can control spectral and temporal resolution and even compress attosecond pulses with a high precision of reproducibility. Simulations and optimizations of multilayer systems as well as experimental results of XUV measurements are presented.

DS 20.2 Wed 9:45 H 0111

Single-Shot Imaging of Transient Reflectivity Changes for Temporal Jitter Characterization in Ultrafast X-ray Pump-Probe Experiments — M. Beye[3], M. Bionta[2], S. de Jong[2], A. Galler[1], C. Graves[2], J. Gruenert[1], M. Holmes[2], O. Krupin[1,2], •B. Li[1], R. Marvel[4], M. Minitti[2], A. Reid[2], and W. F. Schlotter[2] — [1]European XFEL GmbH, Hamburg, Germany — [2]SLAC National Accelerator Laboratory, CA 94025, USA — [3]Helmholtz Zentrum Berlin, Germany — [4]Vanderbilt University, Nashville 37235, USA

The X-ray Free-Electron-Laser sources will enable frontier research in the studies of extremely small structures (angstrom resolution) and extremely fast phenomena (<10 fs) at the same time. The origin of a Self-Amplified Spontaneous Emission-based FEL is the shot noise in the electron bunch, and thus each individual FEL pulse is different in terms of pulse energy, spectrum, wavefront, temporal properties etc. Measuring the temporal profile of the ultrafast FEL pulse remains a very challenging topic [1-2]. Here we report on recent results from a research campaign at the LCLS SXR instrument, where single-shot images of the cross-correlation of XFEL pulses and infrared laser pulses are measured and analyzed. The X-ray induced transient change of optical reflectivity is observed and the time delay in-between the X-ray pulses and optical laser pulses could also be derived preliminarily.

[1] Nature Photonics, 2, 165 (2008). [2] J. Phys. B: At. Mol. Opt. Phys., 43, 194010 (2010).

DS 20.3 Wed 10:00 H 0111

Fabrication of multilayer Laue lenses for high resolution hard x-ray microscopy — •Liese Tobias[1], Radisch Volker[1], Ruhlandt Aike[2], Krüger Sven Philip[2], Giewekemeyer Klaus[2], Osterhoff Markus[2], Salditt Tim[2], and Krebs Hans-Ulrich[1] — [1]Institut für Materialphysik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Institut für Röntgenphysik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

High resolution microscopy using both soft and hard x-rays is highly useful for biological and material sciences. Especially for spatial resolutions in the 10 nm range, highly-precise optical devices like Kirkpatrick-Baez mirrors, waveguides, compound refractive lenses or zone plates are required. As an alternative to conventional zone plates, also multilayer structures are applied, mostly fabricated by sputter-slice technique so far. However, multilayer zone plates (MZP) and Laue lenses (MLL) can also be fabricated by a combination of pulsed laser deposition (PLD) and focused ion beam (FIB) [1,2]. In this contribution, we show the design of a multilayer Laue lens for efficient focusing of hard x-rays in one dimension, the necessary optimization steps for the W/Si multilayer deposition, and the FIB fabrication from the deposited multilayer. First synchrotron experiments demonstrate the application for high resolution microscopy below 10 nm.

[1] T. Liese, V. Radisch and H.-U. Krebs, Rev. Sci. Instr. 81 (2010) 073710; [2] T. Liese,V. Radisch, I. Knorr, M. Reese, P. Großmann, K. Mann and H.-U. Krebs, Appl. Surf. Sci. 257 (2011) 5138.

DS 20.4 Wed 10:15 H 0111

LTO and LFP Thin Film Electrodes — •Frank Berkemeier, Wunde Fabian, Köhler Mathias, and Schmitz Guido — Institut für Materialphysik, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm Str. 10, 48161 Münster, Germany

Thin films of lithium titanium oxide (LTO) and lithium iron oxide (LFP) were prepared by reactive ion beam sputtering, in a thickness between 50 and 500 nm. After preparation, the structure of the layers was investigated by X-ray diffraction (XRD) and transmission electron microscopy (TEM). To characterize the electrochemical properties of the layers, i.e. their capability to reversibly intercalate/deintercalate lithium, cyclic voltammetry (CV) and galvanostatic intermittent titration technique (GITT) was performed. It was found that in both cases, the electrochemical performance strongly depends on the conditions during sputtering, i.e. substrate temperature and oxygen partial pressure. When using optimum deposition conditions, reversible capacities of about 88 mAh/g (LTO) and 40 mAh/g (LFP) were found. Using LTO and LFP films that match each other with respect to their capacity, the electrochemical functionality of the films was demonstrated, combining both materials in a galvanostatic cell, and performing continuous CV measurements. In addition to these performance tests, the diffusion coefficient of lithium inside the films was determined by GITT, using thin film approach. Due to the well-defined thickness of the films, this approach can be used quite reliably, and shows in case of e.g. LTO that the diffusion coefficient of lithium only slightly depends on concentration within the regime of reversible cycling.

DS 20.5 Wed 10:30 H 0111

The Dependence of Field Effect Mobility on Layer Thickness in Ultra-Thin Film, Solution Processed, Indium Zinc Oxide TFTs — •Daniel Walker[1], Marc Häming[2], Alexander Issanin[2], Andreas Klyszcz[2], Mareiki Kaloumenos[2], Christian Melzer[1], Heinz von Seggern[1], Rudolph Hoffmann[2], Klaus Bonrad[2], and Peer Kirsch[2] — [1]TU Darmstadt, FB Materialwissenschaften, D-64287 Darmstadt, Germany — [2]Merck TU Darmstadt Laboratories, D-64287 Darmstadt, Germany

Indium-Zinc Oxide and related inorganic semiconductors are generating significant interest due to their transparency and large field effect mobilites for use in both next generation LCD backplane and flexible electronics. In our solution processed devices which have an ultra-thin active layer, between 5 and 20nm thick, we have found that films of equal thickness have dramatically different field-effect mobility and on-off ratios depending on subtle changes in the method of depositing the layer although the subsequent annealing step where the layer itself is formed remains the same. In some cases the mobilities more than double and exceed 10cm2/Vs. Furthermore we have seen that increasing the layer thickness results in an overall decrease in field effect mobility. The mechanism behind these effects is unclear and examining such thin films presents its own challenges. This talk will discuss different experimental techniques, from electronic measurements to SPM used to examine the obtained films and proposes possible mechanisms behind the enhanced transistor characteristics due to the preparation route.

DS 20.6 Wed 10:45 H 0111

Fabrication and characterisation of CNT via interconnects for application in integrated circuits — •Holger Fiedler[1], Sascha Hermann[1], Stefan E. Schulz[1,2], and Thomas Gessner[1,2] — [1]Chemnitz University of Technology, Center for Microtechnologies (ZFM), 09126 Chemnitz, Germany — [2]Fraunhofer Research Institute for Electronic Nano Systems (ENAS), 09126, Germany

Carbon nanotubes (CNT) have special properties, like high electrical and thermal conductivity as well as a strong resistance towards electromigration. This is why CNTs are potential candidate to replace copper in integrated circuits as interconnect material. We designed and fabricated CNT vias based on a metal/CNT hybrid technology. Via structures were patterned using a damascene process flow. Multiwall carbon nanotubes (MWCNT) were vertically grown in vias by chemical vapour deposition on a metallic substrate. Site-selectivity is achieved by employing surface-catalyst interactions to restrict CNT growth to the vias. The gaps between the CNTs were filled with silicon dioxide by decomposition of tetraethylorthosilicate. This is stabilizing the CNT arrays for a subsequent chemical mechanical planarization (CMP). Employing CMP provides two major benefits. Firstly, all shells of the MWCNT can be contacted and therefore contribute to the number of conductive paths. Secondly, due to the flatter surface after CMP, the deposition of the top contact layer is homogeneous, which significantly improves the metal-CNT contact. IV characteristics were obtained from 440 structures per wafer. 95% of the dies investigated show a resistance below 1 kΩ.

DS 20.7 Wed 11:00 H 0111

Unabhängige Temperaturkontrolle bei der Abscheidung von MPCVD-Diamantschichten — •Reinhard Remfort, Nicolas Wöhrl und Volker Buck — Universität Duisburg Essen und CeNIDE, 47057 Duisburg, Deutschland

Die MPCVD (Microwave Plasma Chemical Vapor Deposition) bietet eine etablierte Möglichkeit zur Herstellung großflächiger und besonders reiner bzw. gezielt dotierter Diamantschichten. Die Erzeugung solch maßgefertigter Diamantschichten erfordert eine genaue Kontrolle der Prozessparameter die im allgemeinen jedoch nicht unabhängig voneinander einstellbar sind. Eine besonders wichtige Variable ist die Substrattemperatur, da sie unter anderem maßgeblich die Morphologie der wachsenden Schicht bestimmt. Die Substrattemperatur ist stark abhängig von Plasmaparametern welche selbst wieder von den restlichen Prozessparametern abhängen. Um die Substrattemperatur unabhängig von diesen Parametern kontrollieren zu können, wurde eine Aerosolkühlung mit entsprechender Steuerung in den Substrathalter einer MPCVD-Anlage eingebracht. Die zur Regelung notwendige Temperaturmessung des Substrates erfolgt berührungslos mittels eines Pyrometers seitlich über ein im MW-Resonanzraum angebrachtes Periskop. Die Anordnung ermöglicht daher eine plasmaunabhängige Temperaturmessung. Einzelne Parameter wie zum Beispiel der Abstand des Substrates vom Plasma, können variiert werden ohne dabei die Substrattemperatur zu beeinflussen. Infolge dieser, von anderen Parametern unabhängigen Temperaturkontrolle, wird ein weiterer Freiheitsgrad für die Maßfertigung von Diamantschichten gewonnen.

DS 20.8 Wed 11:15 H 0111

Biofunctionalization of diamond like carcon layers — •Sven Möller[1], Jana Sommerfeld[1], Thomas Keller[2], and Carsten Ronning[1] — [1]Institute of Solid State Physics, University of Jena, Helmholtzweg 3, 07743 Jena — [2]Institute of Material Science and Technology, University of Jena, Löbdergraben 32, 07743 Jena

Diamond like carbon (DLC) is known to be a promising material for various biomedical applications. Due to this capability we have investigated its interaction with biological material like proteins. The DLC layers in this work have been prepared via mass separated ion beam deposition (MSIBD) on silicon substrates. For this purpose, carbon ions were accelerated with a voltage of 30 kV, separated by a 90° sector magnet and focused by a system of electron lenses. For deposition on the substrate, the ions were decelerated afterwards down to a few hundred eV. The ion energy at the end of the deposition process works as an indicator for the sp^3 content respectively the diamond likeness of the layer. Furthermore the surface can be changed by ion beam irradiation additionally in order to create regions with different surface properties. A solution containing the designated proteins were applied to the substrate, which has been analyzed afterwards using several techniques like atomic force microscopy for roughness measurements and contact angle measurements to study the wettability.