HL 52: Devices

Time: Wednesday 9:30–11:30 Location: POT 06

HL 52.1 Wed 9:30 POT 06

Full Range Electrothermal Modeling of Organic Light-emitting Diodes — •Axel Fischer, Koen Vandewal, Simone Lenk, and Sebastian Reineke — Dresden Integrated Center for Applied Physics and Photonic Materials (IAPP), TU Dresden

Organic light-emitting diodes (OLEDs) are now considered for lighting and signaling in the automobile sector, but the requirements are harsh. Moreover, cars have to operate at different ambient conditions, but the appearance of the lighting should remain the same. For tail and break lights, extreme brightness is needed ($> 10.000\,\mathrm{cd/m^2}$) in order to ensure good visibility. As a consequence, high current and power densities are applied which lead to self-heating and unpleasant inhomogeneities of the light emission, neutralizing the benefits of OLED technology such as extraordinary designs. These issues arise due to the fact that OLEDs show a strong dependence between conductivity and temperature, leading to nonlinear electrothermal feedback [Fischer *et al.*, Adv. Funct. Mater., 2014, 24]. Thus, developing accurate electrothermal models for OLEDs is of great interest to establish a future thermal management strategy, holding the brightness as well as its lateral homogeneity constantly high. Here, we present an electrothermal model for OLEDs which nicely matches the full operational range, regarding voltage and temperature and by that is able to reproduce experimentally observed "S"-shaped current-voltage characteristics upon Joule self-heating. Besides that, our approach considers recombination and drift related phenomena, giving valuable insights to the physics of OLEDs.

HL 52.2 Wed 9:45 POT 06

Detection of Terahertz radiation with a graphene-based Schottky Diode — •Maria Schlecht[1], Christian Müller-Landau[1], Alexander Glas[1], Sascha Preu[2], Stefan Malzer[1], and Heiko B. Weber[1] — [1]Lehrstuhl für Angewandte Physik, FAU Erlangen-Nürnberg (FAU), Erlangen, Germany — [2]Dept. of Electrical Engineering and Information Technology, Technische Universität Darmstadt, Germany

We report on the design, fabrication and characterization of a graphene-based Schottky diode for detection of Terahertz (THz) radiation. With epitaxially grown graphene on n-type silicon carbide one can define ohmic and Schottky contacts side-by-side on a silicon carbide wafer, forming a lateral Schottky diode [1]. Due to the nonlinearity of the IV-curve THz radiation is rectified and one measures a DC current proportional to the amplitude of the THz radiation. The responsivity scales with the second derivative of the IV-curve. Furthermore, we detected THz radiation from 70 GHz to 350 GHz using a nipnip-THz source [2]. We achieved a maximal responsivity of 30 mA/W, i.e. 1200 V/W at 78 GHz. The ability of the device to rectify THz radiation is strongly limited by the RC-roll off [2]. In order to increase the 3dB roll off frequency, we compared the nitrogen-implanted Schottky diodes with phosphor-implanted ones which have a much lower serial resistance. [1] S. Hertel et al. Nature comm. 3:951 (2012) [2] S. Preu, et al. J. Appl. Phys. 109, 061301 (2011)

HL 52.3 Wed 10:00 POT 06

Cognitive and memory devices based on Debye length modulation — •Kai-Uwe Demasius — Max Planck Institut für Mikrostrukturphysik, Halle (Saale)

By using a modulation of the screening length in semiconducting and metal-to-insulator transition materials we might reach much higher data storage densities and acess times for ferroelectric memories. A metal-insulator-semiconductor-insulator-metal (MISIM) stack might act as a switch for electric fields, which is interesting to switch and read out the polarization of a ferroelectric material. Furthermore the field transmission through through MISIM-structure shows a hyperbolic tangent behaviour which is interesting as an activation function for artificial neuronal networks.

HL 52.4 Wed 10:15 POT 06

Single-Emitter Regime and Lasing in High-Q Micropillars with Site-Controlled Quantum Dots — •Arsenty Kaganskiy, Tobias Heuser, Jan Grosse, Alexander Schlehahn, Sören Kreinberg, Fabian Gericke, Xavier Porte, Tobias Heindel, Sven Rodt, André Strittmatter, and Stephan Reitzenstein — Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstraße 36, D-10623

We report on the realization of quantum dot (QD) - micropillar cavities based on a technology platform called buried stressor approach [1]. This method allows for the site-controlled growth and device integration of QDs with high optical quality. In addition, this approach has the important advantage that the number of site-controlled QDs in the cavity can be controlled by the design of the buried stressor. By fine tuning the gain, one can operate these devices as few-QD microlasers or even in the single quantum dot regime. Moreover, the buried-stressor approach ensures that the ensemble with a controlled number of QDs is located in the electric field maximum in the center of the micropillars. The fabricated micropillars exhibit Q-factors up to 30000 at an emission wavelength of 932 nm. Single-QD Purcell-enhancement of the emission is investigated via temperature-induced resonance-tuning. The lasing action of the micropillars is proven by power dependent measurements.

[1] A. Strittmatter et al., Appl. Phys. Lett. 100, 093111 (2012)

Coffee Break

HL 52.5 Wed 10:45 POT 06

Heterostructures of 2D carbon materials for pH-sensing — •David Kaiser[1], Andreas Winter[1], Christof Neumann[1], Thomas Weimann[2], and Andrey Turchanin[1] — [1]Institute for Physical Chemistry, Friedrich Schiller University Jena, 07743 Jena, Germany — [2]Physikalisch-Technische Bundesanstalt, 38116 Braunschweig, Germany

Chemical functionalization of single-layer graphene (SLG) is of key importance for applications in functional electronic devices such as, e.g., field effect transistor (FET) based nanosensors. However, the electronic quality of graphene is typically degraded after the functionalization, which significantly restricts the applications. Here, we employ a route to non-destructive chemical functionalization of graphene via engineering of novel carbon nanomembrane (CNM)/SLG hybrids to build an electrolyte-gate FET sensor which can detect the pH value. We employ SLG grown by methane CVD on Cu foils and amino-terminated 1 nm thick CNMs generated by electron-beam induced crosslinking of aromatic self-assembled monolayers to engineer hybrid CNM/SLG FETs. We show that the intrinsically high electronic quality of pristine SLG is preserved in the amino-functionalized hybrids and that sensing of pH is possible with high sensitivity.

HL 52.6 Wed 11:00 POT 06

Ionic Liquid Gating of Solution Processed MoS2 Thin Film Transistors — •Francis Oliver Vinay Gomes[1,2], Xiaoling Zeng[2], Marko Marinkovic[1], Torsten Balster[2], and Veit Wagner[2] — [1]Evonik Resource Efficiency GmbH, Paul-Baumann-Strasse 1, 45772 Marl, Germany — [2]Jacobs University Bremen, Department of Physics & Earth Science, Campus Ring 1, 28759 Bremen, Germany

Ionic liquid (IL) gating of thin film transistors (TFTs) based on solution processed MoS2 obtained from Mo-precursor solution on various substrates has been investigated. Chemical conversion of the deposited films on silicon and sapphire substrates to MoS2 were obtained by annealing in presence of sulfur. Films deposited on amorphous Si/SiO2 substrates showed random grain orientation. However, improved film growth with oriented grains was observed on crystalline sapphire substrates. Raman and XPS, and TEM measurements revealed formation of polycrystalline MoS2 films with grain size of 100 nm.

TFTs fabricated from MoS2 implementing IL gating through electrostatic carrier accumulation exhibited ambipolar transport with dominant n-type behaviour. TFT performance was observed for films thinner than 9 nm due to gate-channel control and the threshold voltage is dependent on the ratio of IL to host polymer mixture. Sapphire in contrast to silicon substrates demonstrated ten times higher ON/OFF ratio attributed to the improved film growth. The efficient use of IL gating achieved in this wet-chemical MoS2 can be extended to quantitatively study other dichalcogenides for future nanoelectronic devices.

HL 52.7 Wed 11:15 POT 06

Cognitive computing with mem-circuits — •Alessandro Fu-

marola and Stuart Parkin — Max Planck Institute for Microstructure Physics, Halle (Saale), Sachsen-Anhalt, Germany

The time and energy spent transporting information between memory and processor in standard computers (across the so-called 'Von-Neumann bottleneck') has become problematic for data-centric applications such as real-time image recognition and natural language processing[.

Non-VN systems, such as the human brain, are capable of full on-line learning and could be designed moving from reliable but binary devices to dense and analog (but less reliable) nanoscale elements. Previous work has been carried out, for example,with phase-change devices and other non-volatile memories, obtaining high machine learning performance in large-scale hardware/software systems.

In this work, we assess the suitability and advantages of other circuit elements with memory, namely memcapacitors, used as synaptic devices in such Non-VN configurations. Simulated power and performance benchmarks are provided. Possible solid-state implementation of binary and analog memcapacitors are also proposed and characterized.