MM 24: Materials for Sensors and Actuators

Time: Tuesday 11:45–13:00 Location: IFW B

MM 24.1 Tue 11:45 IFW B

Supramolecular Functionalized Pristine Graphene Utilizing A Bio-compatible Stabilizer Towards Ultra-sensitive Ammonia Detection — •Shirong Huang[1], Luis Antonio Panes-Ruiz[1], Alexander Croy[1], Leif Riemenschneider[1], Vyacheslav Khavru[2], Viktor Bezugly[1,2,3], and Gianaurelio Cuniberti[1,3] — [1]Institute for Materials Science and Max Bergmann Center for Biomaterials, Technische Universität Dresden, 01062 Dresden, Germany — [2]Life Science Inkubator Sachsen GmbH & Co. KG, Tatzberg 47, 01307 Dresden, Germany — [3]Center for Advancing Electronics Dresden (cfAED), TU Dresden, 01062 Dresden, Germany

In this work, we develop pristine graphene-based gas sensors utilizing flavin monocleotide sodium salt (FMNS) towards ultra-sensitive ammonia detection. The sensor has 3% response upon exposure to 10 ppm NH3 and a limit of detection of 1.6 ppm at room temperature and shows a good recovery. Raman, UV-vis, FT-IR spectra, as well as SEM measurements are employed to characterized the quality of the graphene flakes, indicating a good structural quality of graphene with few defects. Complementary molecular dynamics simulation results show that FMNS molecules play two important roles for the graphene sensor: to stabilize graphene flakes via supramolecular functionalization and to act as binding sites for NH3 molecules. The process is very mild, environmentally friendly, and low cost. We believe this work may pave a path to design high performance gas sensor with low cost and boost the application of graphene for sensing.

MM 24.2 Tue 12:00 IFW B

Implantable Highly Compliant Devices for Heating of Internal Organs: Toward Cancer Treatment — •Tetiana Voitsekhivska[1], Gilbert Santiago Canón Bermúdez[1], Tetyana Yevsa[2], Inga Hochnadel[2], Jürgen Fassbender[1], and Denys Makarov[1] — [1]Helmholtz-Zentrum Dresden Rossendorf e.V., Institute of Ion Beam Physics and Materials Research, Bautzner Landstrasse 400, 01328 Dresden, Germany — [2]Department of Gastroenterology, Hepatology and Endocrinology, Hannover Medical School, Carl-Neuberg-Str. 1, 30625 Hannover, Germany

Flexible electronics can revolutionize the health care sector. Despite numerous functional flexible devices already demonstrated, tumor treatment remains unexplored in this field. We realized a highly compliant device for targeted heat treatment of tumor sites of internal organs [1], consisting of a 6 μm-thick polymeric foil hosting a heater and temperature sensor, coated with a 5 μm-thick encapsulation layer. We study the electro-thermal and mechanical characterization of the devices and demonstrate that they can be efficiently used to thermally impact normal and cancerous tissues of autochthonous murine models with liver cancer. The device withstood more than 50 bending cycles at 2.5 mm bending radius, retaining the accuracy of 0.2 °C. The developed highly compliant device paves the way for handling of exophytic tumor nodules via thermal destruction of tissue, targeted drug release, or enhancement of antitumor immune responses.

[1] G.S. Canón Bermúdez et al., Adv. Eng. Mater. 21, 1900407 (2019).

MM 24.3 Tue 12:15 IFW B

High compliancy for printed magnetic field sensors — •Minjeong Ha[1], Gilbert Santiago Cañón Bermúdez[1], Tobias Kosub[1], Yevhen Zabila[2], Rico Illing[1], Yakun Wang[1], Jürgen Fassbender[1], and Denys Makarov[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]The H. Niewodniczanski Institute of Nuclear Physics, Krakow, Poland

The development of highly-compliant and skin-conformal magnetic sensors is essential for the human-interactive electronics capable of position recognition and tracking motion. To design such human interactive sensing devices, printing technique is a great approach due to easily tunable and shapable process, cost-effectiveness, and large-area fabrication. Here we report printable magnetoresistive sensors on ultra-thin films that can naturally comply with the skin. Thanks to the new formulation of the paste, the printed magnetic microflakes could firmly attach to any even ultrathin polymeric substrate showing mechanical stability under 16 um bending radius without any damage. The excellent percolation contacts between the randomly distributed microflakes attribute the high sensitivity of 2.2/T in low magnetic field ranges of 1 mT on the bending curvature of 500 um, resulting in 1900 times higher figure of merits than current state-of-the-art printable magnetic sensors. With this performance, our printed sensors on skin demonstrate a touchless control of virtual objects for the practical application in human-interactive wearable devices, artificial prosthetics, robotics, and internet of things.

MM 24.4 Tue 12:30 IFW B

Generation of core-gap-shell microcapsules for stimuli-responsive biomolecular sensing. — •Hyejeong Kim[1], Seong min Jo[2], Fanlong Meng[1], Yinzhou Guo[2], Héloïse thérien Aubin[2], Ramin Golestanian[1], Katharina Landfester[2], and Eberhard Bodenschatz[1] — [1]Max Planck Institute for Dynamics and Self-Organization, Am Faßberg 17, 37077 Göttingen, Germany — [2]Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany

Stimuli-responsive microparticles carrying dedicated cargo have great potential in a variety of technical applications, such as sensor and actuator technologies, drug delivery and catalysis. Here we report results on thermo-responsive core-gap-shell microcapsules (TCGSM) made of Poly(N-isopropylacrylamide), which allow the encapsulation of hydrophilic payloads in a simple, stable, and reliable manner. Different designs of TCGSM were realized by individually controlling the swelling of the inner core and the outer shell or by incorporating pH-responsive co-monomers into the inner core. The gap, i.e. the space between the inner core and the outer shell, can be loaded with dedicated cargo such as nanoparticles. The outer shell can serve as a stimuli-responsive gateway for the exchange of smaller molecules with the external aqueous solution. This is demonstrated with the realization of a temperature controllable enzymatic glucose sensor. The presented platform opens new avenues for the production of stimuli-responsive core-gap-shell microparticles for a multitude of applications.

MM 24.5 Tue 12:45 IFW B

Fabrication of ZnO/Si NWs p-n Heterojunction array based High Response Nitric Oxide (NO) Gas Sensor with Noise Limited Detectivity Approaching 10 ppb — •Chandan Samanta, Ankita Ghatak, A K Raychaudhuri, and Barnali Ghosh — S N Bose National Centre for Basic Sciences, Kolkata, India

Gas sensors, particularly those based on solid state devices are commercially available and are widely used to hazardous gas monitoring and new vistas for application are opening up for solid state gas sensors for use in healthcare such as exhaled breath analysis. In this work we report a ZnO/Silicon nanowires (ZnO/Si NWs) based p-n heterojunction diode array based Nitric Oxide (NO) gas sensor that can show a calibrated detection capability at least down to 0.5ppm (with dry N2 as the ambience gas). Utilization of cost effective chemical technique for fabrication of sensor on silicon is compatible with wafer level processing and easily connecting with silicon IC technology. The vertically aligned Si NWs array has been made by electroless etching method and the ZnO nanostructure was made by chemical solution deposition and spin-coating. We observe that the heterostructure leads to a synergetic effect where the sensing response is more than the sum total of the individual components. Extensive cross-sectional electron microscopy and composition analysis by line EDS allowed us to make a physical model. The comparison of the simulation results with the experiment point out the device parameters that enhance the device response.