NanoNet+ FWIO FWIM

Annual Workshop 2022

2D Materials and ultra-high doped semiconductors: Electronics, photonics and sensing

04 – 06 October 2022

Europa-Jugendherberge, Görlitz, Germany

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HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

Venue and organization

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HZDR HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

NanoNet+ Workshop 2022 - Görlitz

Agenda

Place: Europa-Jugendherberge Görlitz, Peterstr. 15, 02826 Görlitz, Tel. +49 (0)3581 6490700
Web-site: www.hzdr.de/NanoNet-Workshop2022
Updated: 23.09.2022 (PZ)

Tuesday, 04 October 2022

Start	Who	Durat.	Title	Notes
09:30			Departure bus Bhf. Dresden-Neustadt | 'Am Weissiger Bach' at 9:45	
12:00			**Lunch**	
13:00	Erbe, A.	10	Welcome address	Chair: Erbe
13:10	Bussmann, M.	20+5	Understanding matter under extreme conditions at the nanoscale	
13:35	Ghosh, S.	15+5	Novel Mixed Dimensional Reconfigurable Field Effect Transistors: Fabrication and Characterization	
13:55	Khan, Bilal	15+5	Towards Atmospheric Radical Sensing: Fabrication of Junctionless Transistors	
14:15	Vardhan, V.	15+5	Junctionless Nanowire Transistor based sensors for Atmospheric pollutants and detergents	
14:35	Heinzig, A.	40+5	Reconfigurable electronics based on 1D and 2D nanostructures	
15:30		100	Coffee + Poster Session	13+2 Posters
17:30		90	**Guided City Tour (start in front of hostel)**	
19:00			**Dinner**	
20:30	Biswas, S.	15+5	Converting waste heat into electrical energy in ionic nanofluidic membranes	Chair: Khan, Bilal
20:50	Jagtap, N.	15+5	Effect of He+ implantation on nanomechanical resonators in 3C-SiC	**Evening Session**
21:10	Fowley, C.	15+5	Cleanroom: capabilities, recent upgrade and future plans	
21:30			Brain Storming	

Wednesday, 05 October 2022

Start	Who	Durat.	Title	Notes
08:30	Berencen, Y.	15+5	On the silicon-photonic route to quantum communication and computing	Chair: Prucnal
08:50	Shaikh, M.	15+5	On-chip room-temperature planar PIN Si:Te photodiodes for short-wavelength infrared detection	
09:10	Bratschitsch, R.	40+5	Single-photon emitters in 2D materials	
10:00		30	Break	
10:30	Zahn, D.R.T.	40+5	Nanospectroscopy of hybrid plasmonic / low-dimensional semiconductor structures	Chair: Zhou
11:15	Li, Yi	15+5	Modification of two-dimensional materials using ion implantation	
11:35	Fekri, Z.	15+5	Black phosphorus field-effect transistors and their applications	
11:55	Chava, P.	15+5	Tunneling transport in van der Waals heterojunctions enabled by a two-dimensional device architecture	
12:20			**Group Photo** (in front of canteen)	
12:30			**Lunch**	
13:45	Jamshidi, K.	40+5	Photonic ICs for communications and computing	Chair: Berencen
14:30	Echresh, A.	15+5	Axial p-n junction photodetectors based on single germanium nanowires	
14:50		30	Break	
15:40	Departure		**Walking Tour Landeskrone** or **Museum Barock-Haus**	Tram #2 16:00
19:00			**BBQ Dinner**	

Thursday, 06 October 2022

Start	Who	Durat.	Title	Notes
08:30	Steuer, O.	15+5	Band-gap and strain engineering in $Ge_{1-x}Sn_x$ alloys using post-growth pulsed laser melting	Chair: Fowley
08:50	Khan, Moazzam	15+5	Group IV Nanowires for Reconfigurable Field Effect Transistors	
09:10	Fischer, I.	40+5	Integrated Refractive Index Sensors: Combining Plasmonic Nanostructures with Group-IV Devices	
10:00		30	Break	
10:30	Frank, O.	40+5	Nanospectroscopic fingerprints of van der Waals interactions in 2D materials	Chair: Georgiev
11:15	Krause, M.	15+5	High-temperature in-air stable transparent conductive oxide SnO2:Ta	
11:35	Garcia, A.	15+5	Environment-dependent friction, Raman and μ-RBS study of MoS_2 coatings deposited by filtered Laser-Arc	
12:00		10	Prize Ceremony	
12:30			Lunch	
14:00			Departure: **Bus Stop 'Nikolai-Turm' - 5 min. walk**	

Breakfast will be served from 7:30 am. Most rooms will be available at arrival, latest 4 pm.

Your Notes

NanoNet+ Workshop 2022 - Görlitz

Talks

updated: 29.09.2022 (PZ)

List of Poster Contributions see page 27.

Single-photon emitters in 2D materials

Rudolf Bratschitsch

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Atomically thin materials serve as a promising new material class for optoelectronics. Monolayer semiconductors such as MoS_2 or $MoSe_2$ exhibit prominent photoluminescence. Recently, we have discovered bright and stable single-photon emitters in single layers of WSe_2 [1], which renders atomically thin semiconductors also interesting for quantum optics and quantum technologies [2]. In my talk, I will show that these quantum light sources can be controlled by mechanical strain and demonstrate deterministic positioning of the emitters on the nanoscale [3]. Furthermore, I will present single-photon emission from GaSe [4], and demonstrate that the photons can be routed in dielectric waveguides on a photonic chip [5]. Finally, I will discuss the nature and prospects of single-photon emitters in the van der Waals insulator hexagonal boron nitride (hBN). I will focus on how large emitter arrays can be created with commercially available hBN nanocrystals [6] and demonstrate ultrafast coherent control of a single hBN emitter [7].

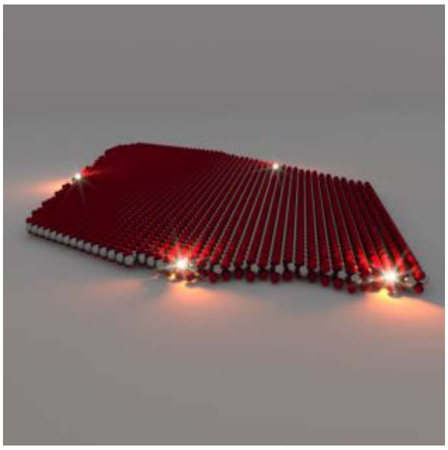

Figure 1: Artistic impression of a WSe_2 monolayer with several single-photon emitters.

References

[1] P. Tonndorf et al., Optica 2, 347 (2015)
[2] S. Michaelis de Vasconcellos et al., Phys. Status Solidi B 259, 2100566 (2022) (review)
[3] J. Kern, Advanced Materials 28, 7101 (2016)
[4] P. Tonndorf et al., 2D Materials 4, 021010 (2017)
[5] P. Tonndorf et al., Nano Letters 17, 5446 (2017)
[6] J. A. Preuß et al., 2D Materials 8, 035005 (2021)
[7] J. A. Preuß et al., Optica 9, 522 (2022)

Understanding matter under extreme conditions at the nanoscale

Michael Bussmann[1,2], Attila Cangi[1,2], Tobias Dornheim[1,2], Alexander Debus[2], and Thomas Kluge[2]

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The study of matter under conditions usually found in astrophysical objects has been accelerating with the advent of new research facilities such as the Helmholtz International Beamline for Extreme Fields at the European XFEL. With such instruments, studying matter far off equilibrium situations under the influence of extreme fields, temperatures and pressures allows for hitherto unprecedented views into the dynamics of highly excited materials at the atomic scale.

Models based both on data and large-scale simulations profit from this development and in turn help us increase the quality of our models for matter under ambient conditions and close to equilibrium.

I will present a few recent highlights of studying these complex systems and discuss the role of modern digital technologies in increasing our understanding of these models.

Integrated Refractive Index Sensors: Combining Plasmonic Nanostructures with Group-IV Devices

Inga A. Fischer[1], Weijia Han,[1,*] Sebastian Reiter,[1] Jon Schlipf,[1] Christian Mai,[2] Davide Spirito,[2] Josmy Jose,[2] Christian Wenger,[2,3]

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Nanostructures can be used to tailor light-matter interaction in many ways: Plasmonic nanoantennas composed of metallic nanoparticles enable the control and manipulation of optical energy in the visible and near-infrared spectrum. Furthermore, the optical properties of structures such as plasmonic nanohole arrays are highly sensitive to changes in the refractive index in the vicinity of the structures. The combination of plasmonic nanohole arrays with group-IV optoelectronic devices can be a strategy for the large scale fabrication of miniaturized and cost-effective refractive index sensors on the Si platform. However, complementary metal-oxide-semiconductor (CMOS) fabrication processes place restrictions in particular on the metals that can be utilized. Here, we present results on using Al and TiN nanohole arrays in combination with Ge photodetectors for applications as integrated, plasmonic refractive index sensors. Our photocurrent spectra show how such devices can be utilized to detect surface refractive index changes under simple top illumination and without the support of signal amplification circuitry. Our results, therefore, can be taken as the starting point for integrated devices that harness the cost-effectiveness of the Si CMOS platform for low-cost biosensors based on plasmonic effects.

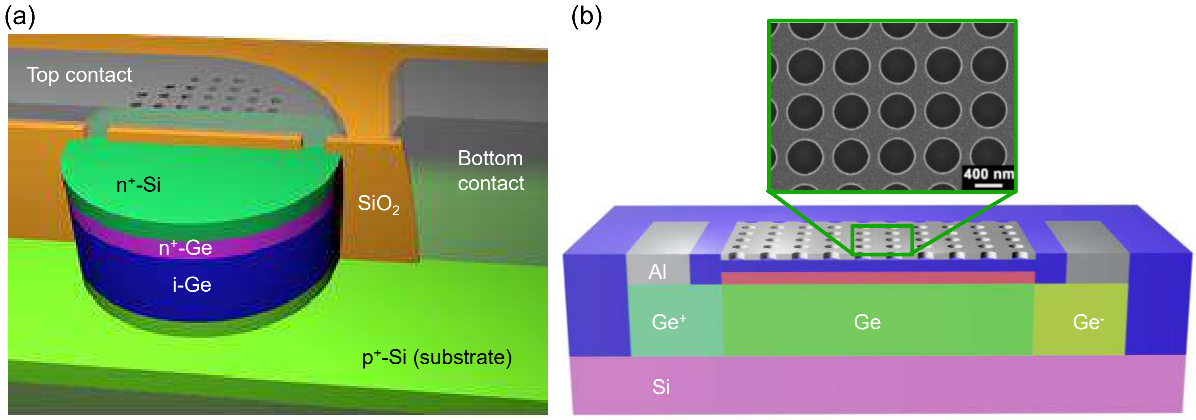

Fig. 1: Ge PIN heterostructure photodetectors with (a) Al and (b) TiN nanohole arrays structured directly into the photodetector metallization.

Nanospectroscopic fingerprints of van der Waals interactions in 2D materials

Otakar Frank

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Two-dimensional materials and heterostructures formed by stacking of their individual layers are at the forefront of current materials research. Their spectroscopic investigation relies mostly either on diffraction-limited microRaman or photoluminescence (PL), which do not properly capture local structural variations caused by, e.g., nanometre-sized heterogeneities stemming from contamination trapped either between the bottom-most layer and its substrate or in the interlayer galleries.

Tip-enhanced spectroscopy methods enable the access to information on the local lattice deformation and also on the interaction between the individual layers composing the heterostructure. Herein, we will show specific Raman and PL signatures that allow such nanoscale characterization of monolayer (1L) transition metal dichalcogenides (TMDCs) and their heterobilayers. Tip-enhanced Raman spectroscopy (TERS) of 1L TMDCs on gold, with lateral resolution as low as 10 nm, shows heterogeneity of interaction between the TMDC layer and the substrate, resulting in large shifts of all normal modes – in contrast to microRaman spectra, which show an apparent splitting of the modes [1,2]. In addition, certain modes, otherwise inactive in layers which are suspended or only weakly interacting with the substrate, become Raman active due to lattice symmetry change in the presence of a strongly interacting substrate [2]. In TMDC heterobilayers, tip-enhanced photoluminescence (TEPL) can be used to visualize the interlayer excitons as well as to follow the intralayer excitons, intensities of which correspond to the level of interaction [3]. Finally, by using the unique ultra-low frequency TERS setup, interlayer phonons provide an additional, straightforward way for nano-optical characterization of TMDC heterostructures [4].

References

[1] Velicky et al. J. Phys. Chem. Lett. 11, 6112 (2020)
[2] Rodriguez et al. Phys. Rev. B 105, 195413 (2022)
[3] Rodriguez et al. 2D Mater. 8, 025028 (2021)
[4] Rodriguez et al. J. Phys. Chem. Lett. 13, 5854 (2022)

Reconfigurable electronics based on 1D and 2D nanostructures

André Heinzig[1,2], Wenwen Fei[1,2], Tom Mauersberger[1,2], Thomas Mikolajick[1,2,3]

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For over 50 years, increasing integration density was the primary driver for electronics, as each technological generation provided more functions at equal costs. By foreseeable reaching the economic and physical limitations of scaling, novel concepts of electronic switches are of great interest to research and industry.
The reconfigurable field effect transistor (RFET), which can be switched from p-type to n-type by an electrical signal (Fig. 1a), offers an alternative building block to increase the functional density of electronic circuits. Moreover, the first approaches could be published to realize novel hardware security concepts and neural networks using transistor-level programming in reconfigurable electronic circuits.
The presentation will introduce the control of electron and hole transport based on independent charge carrier injection on nanostructure junctions. The electrical characteristics are demonstrated and analyzed on fabricated silicon nanowire transistors. In particular, the charge carrier tunneling process will be evaluated, and optimizations to enable performance improvements and circuit suitability will be shown. Simulations will give insights into the dependencies of different structures and materials on the electrical device characteristics. Furthermore, the importance of some prerequisites of energy-efficient CMOS integration, such as electrical symmetry and the use of uniform voltages, will be discussed and shown by simple demonstrator circuits. Additionally, the talk will illustrate the excellent theoretical suitability of 2D semiconductor materials for the realization of 2D based reconfigurable electronics. In conclusion, it will show our group's first results on ambipolar and 2D-RFETs device measurements (Fig. 1b).

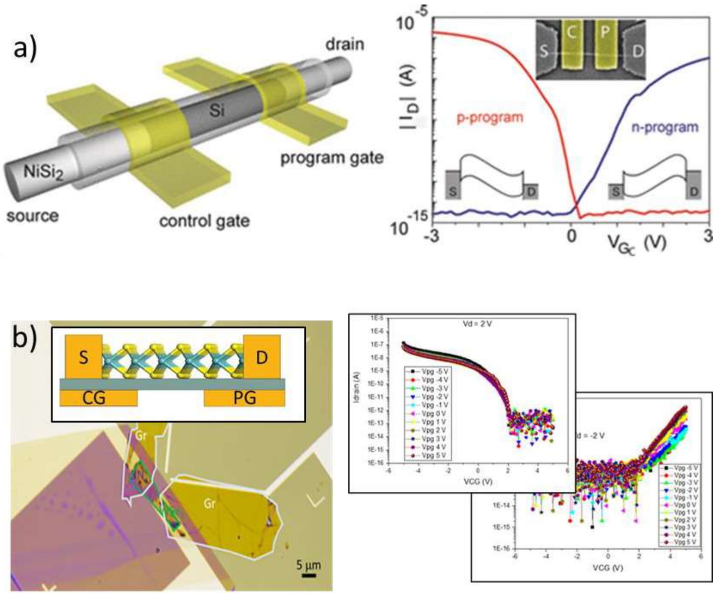

Fig. 1) Different implementations of reconfigurable transistors and their transfer characteristics. a) Silicon nanowire based RFET, b) WSe2 based 2D-RFET. Independent carrier control enables reversible p-type and n-type configuration regardless of the semiconductor material.

Photonic ICs for communications and computing

Kambiz Jamshidi, Mircea Catuneanu, Shahryar Sabouri, Sourav Dev, Menglong He, Hilal Tunc, Hrishikesh Vithalani

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Research in the field of integrated photonic devices and systems has been emerging faster than ever in recent years due to the efforts made by several research groups and commercial enterprises. Several foundries all over the world provide fabrication services to researchers to fabricate photonic components. In the IPD group, we use a fabless model to design photonic circuits to realize the functionalities required for several applications.

For the realization of optical interconnects, adaptivity and energy efficiency are the main performance metrics. In this talk, the results of the design and implementation of high-speed data modulators as well as optical phase arrays using the available platforms to realize adaptive energy-efficient optical (wired and wireless) links will be presented. Also, the challenges to modeling and measurement of microring resonators and their exploitation in non-classical computing applications, like the Ising machine will be discussed.

Tip-enhanced spectroscopies for studying 2-dimensional semiconductors and their interfaces

Dietrich RT Zahn

Semiconductor Physics and Center for Materials, Architecture, and Integration of Nanomembranes (MAIN), Chemnitz University of Technology, Germany

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Two-dimensional (2D) semiconductors are one of the most extensively studied materials showing potential in a large spectrum of applications from electronics/optoelectronics to photocatalysis and CO2 reduction. These materials possess astonishing optical, electronic, and mechanical properties, which are different from their bulk counterparts. Due to strong dielectric screening, local heterogeneities such as edges, grain boundaries, defects, strain, doping, and chemical bonding dictate their physical properties to a great extent. Therefore, there is a growing demand of probing such heterogeneities and their effects on the physical properties of 2D semiconductors on site in a label-free and non-destructive way. Tip-enhanced Raman spectroscopy (TERS), which combines the merits of both scanning probe microscopy and Raman spectroscopy, has experienced tremendous progress since its introduction in the early 2000s and is capable of local spectroscopic investigation with nanometer spatial resolution. Introducing this technique to 2D semiconductors not only enables us to understand the effects of local heterogeneities, it can also provide new insights opening the door for novel quantum mechanical applications.

In this contribution, we deliver a short introduction to the most commonly used 2D semiconductors, namely the transition metal dichalcogenides (TMDCs), and their properties. Subsequently we briefly introduce the basics of TERS as well as tip-enhanced photoluminescence (TEPL). Then we discuss several examples highlighting the application of tip-enhanced optical spectroscopies (TEOS) to 2D semiconductors.

On the silicon-photonic route to quantum communication and computing

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Indistinguishable single-photon sources at telecom wavelengths are the key photonic qubits for transmitting quantum information over long distances in standard optical fibers with minimal transmission losses and high fidelity. This enables secure quantum communication over the quantum internet and, in turn, a modular approach to quantum computing. The monolithic integration of single-photon sources with reconfigurable photonic elements and single-photon detectors in a silicon chip is a key enabling step toward demonstrating scalable quantum hardware such as quantum photonic integrated circuits (QPICs). Nowadays, nearly all the necessary components for QPICs are available such as superconducting single-photon detectors, low-loss photonic waveguides, delay lines, modulators, phase shifters, and low-latency electronics. Yet, the practical implementation of scalable quantum hardware has been largely hampered by the lack of on-chip single-photon emitters in silicon that can be created at desired locations on the nanoscale.

Here, we demonstrate two complementary wafer-level protocols for the creation of single telecom-wavelength color centers in silicon with a probability exceeding 50%. Both approaches are fully compatible with current silicon technology and enable the scalability of millions of single telecom quantum emitters that are created at desired nanoscale positions on a silicon chip. These results unlock a clear pathway for industrial-scale QPICs.

Converting waste heat into electrical energy in ionic nanofluidic membranes

Subhajit Biswas

Ievgen Nedrygailov, Kamil Rahme, Anjali Ashokan, Rupa Ranjani, Subhajit Biswas and Justin D. Holmes

School of Chemistry & the Environmental Research Institute (ERI), University College Cork, Cork, Ireland

Waste heat energy discharged into the atmosphere is one of the largest sources of clean, fuel-free and inexpensive energy available. Although technologies such as thermoelectric and thermo-electrochemical cells have been around for a long time, there is still no environmentally sustainable and efficient technology platform available for viable harvesting of low-grade waste heat. The central aim of our project (TRANSLATE) is to develop a nanofluidic platform technology based on large ion flux in nanochannels under a thermal gradient. This technology utilises Earth-abundant materials such as anodic aluminum oxide (AAO) and cellulose membranes for the development of a versatile and sustainable energy harvesting and storage platform.

This presentation will provide an overview of the project on low-grade waste heat harvesting in ionic nanofluidic membranes. A key enabler for achieving greater waste heat to electrical energy conversion efficiencies is the overlap of electric double layers (EDLs) in very narrow channels. These overlapping EDLs cause a surge of ions (ion flux) into the 'hot entrances' of the nanochannels resulting in an enhanced thermovoltage, *i.e.* high waste heat conversion. The nanochannels with a diameter of ~10 nm and a length ranging from a few micrometers to several millimeters are created by two-stage aluminum anodization (for AAO), chemical treatment of natural wood (for cellulose). To increase the charge density, the surface of the nanochannels is functionalized, which leads to the appearance of overlapping EDL. We will present initial experimental results with aqueous electrolytes (KCl, NaCl etc.) that are capable of converting low-grade heat with thermopowers up to 1–3 mV/K, which is higher than that of conventional solid-state thermoelectric converters. Variation of the geometric parameters of the nanochannels, the type and concentration of the electrolyte, as well as the surface charge density of the nanochannels can result in a much higher ionic thermovoltage. With such a high thermopower, ionic nanofluidic membranes can be a game changer in the field of thermoelectric power conversion.

Tunneling transport in WSe_2-MoS_2 heterojunction transistor enabled by a two-dimensional device architecture

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Abstract
Heterojunctions made of two-dimensional (2D) semiconducting materials provide promising properties for the realization of tunnel field effect transistors (TFETs). The absence of dangling bonds allows the formation of sharp hetero-interfaces, which enables the reduction of parasitic components arising due to interface traps. We demonstrate band-to-band tunneling (BTBT) between layers of WSe_2 and MoS_2 that are contacted with few-layered graphene (FLG) on both sides of the junction and completely encapsulated with hexagonal boron nitride (h-BN). Additionally, we also use the FLG as a gate electrode, which allows us to realize devices made entirely of different 2D materials. Previous reports on WSe_2-MoS_2 junctions showing tunneling transport use a combination of high-k dielectrics, ion gel dielectric, doped flakes, or different sets of contact metals. We observe negative differential resistance (NDR) confirming the tunneling transport in our devices without using any of the above mentioned additional fabrication steps, showing the potential in terms of further optimization.

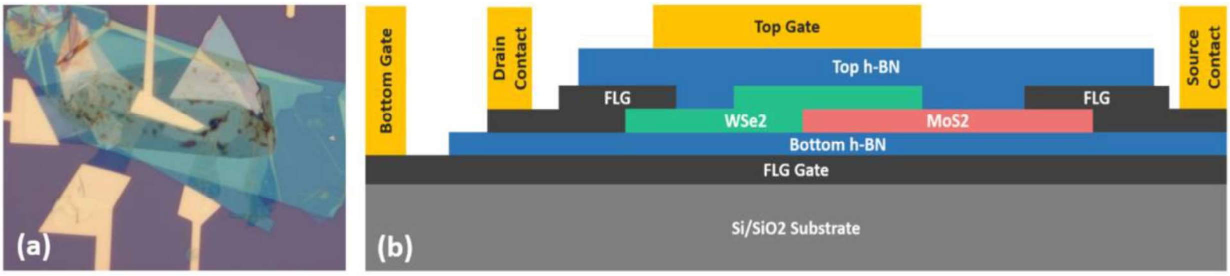

Figure 1: (a) Optical micrograph of the fabricated device with contact electrodes (b) Corresponding cross sectional schematic of the device showing the individual 2D layers used.

Axial p−n junction photodetectors based on single germanium nanowires

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Abstract

Germanium (Ge) is considered as a promising candidate for designing near-infrared photodetectors. Ge has a bandgap of 0.67 eV, which induces a large absorption coefficient at near-infrared frequencies. Also, Ge has excellent compatibility of parallel processing with silicon technology [1,2]. Photodetectors based on Ge material have been fabricated with different structures such as metal-semiconductor-metal (MSM) and p−n junctions. On the other hand, the observation of high photoresponsivity in semiconductor nanowires with a high surface-to-volume ratio has attracted growing interest in using nanowires in photodetectors. So far, significant efforts have been made to fabricate single nanowire based photodetectors with different materials such as Si, Ge, and GaN to achieve miniaturized devices with high responsivity and short response time [3-5]. Hence, Ge nanowires are an excellent candidate to fabricated single nanowire based near-infrared photodetectors.

In this work, we report on the fabrication and characterization of an axial p−n junction along Ge nanowires with different widths. First, through a resist mask created by electron beam lithography (EBL), the Ge layers were locally doped with phosphorus ions using ion beam implantation followed by rear-side flash lamp annealing. Then, the single Ge nanowire based photodetectors containing an axial p−n junction were fabricated using EBL and inductively coupled plasma reactive ion etching (ICP-RIE). The fabricated single Ge nanowire devices demonstrate the rectifying current-voltage characteristic of a p−n diode in dark conditions. Moreover, the photoresponse of the axial p−n junction based photodetectors was investigated under three different illumination lights of 637 nm, 785 nm, and 1550 nm wavelengths. It appears that fabricated photodetectors can be operated at zero bias and at room temperature under ambient conditions. A high responsivity of 3.7×10^{2} AW^{-1}, and detectivity of 1.9×10^{13} $cmHz^{1/2}W^{-1}$ were observed at zero bias under illumination of 785-nm-wavelength. The responsivity of the single Ge NW photo-detectors was increased by applying a reverse bias of 1V.

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Black phosphorus field-effect transistors and its applications

Zahra Fekri[1], Himani Arora[1], Yagnika Nandlal Vekariya[1], Victoria Constance Köst[2], Krzysztof Nieweglowski[2], Phanish Chava[1,2], Kenji Watanabe[3], Takashi Taniguchi[4], Manfred Helm[1,2], and Artur Erbe[1,2]

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Black phosphorus (BP) has been known as a more favorable material in many applications compared to other 2D materials due to its exceptional properties. However, its sensitivity to air species has restricted its integration into active devices.
In this work, we used a few nm thickness BP for developing field-effect transistors (FETs). A lithography-free via-encapsulation scheme allows us to fabricate fully-encapsulated BP-based field-effect transistors and perform reliable electrical measurements. Based on our results, we find that the electronic properties of the via-encapsulated BP FETs are significantly improved compared to non-encapsulated devices. We further demonstrated a gas sensing performance based on the BP FET. Our preliminary result shows the promising potential of BP for applications in advanced gas-sensing technology.

IBC Cleanroom

Ciaran Fowley

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I will give an overview of the capabilities and recent successes of the Ion Beam Center (IBC) Cleanroom at HZDR, including how it functions to serve the needs of students, postdocs and group leaders.

Environment-dependent friction, Raman and μ-RBS study of MoS_2 coatings deposited by filtered Laser-Arc

Dr. Aurelio García-Valenzuela[1*], Lars Lorenz[2], Dr. Frans Munnik[1], Dr. Stefan Makowski[3], Dr. Matthias Krause[1]

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Historically, molybdenum-disulfide (MoS_2) has been employed as a space lubricant due to its affinity for vacuum environments [1]. However, it is well established that the performance of MoS_2 breaks down in humid air environments due to oxidation to MoO_3 and disruption of van der Waals sliding [2]. Additionally, while MoS_2 lubricants were able to meet the requirements of early spacecraft, longer mission durations continue to push the demands placed on these lubricants requiring ultrahigh wear lives on the order of decades instead of months. Plasma filter techniques implemented in recent years enable nowadays the production of MoS_2 coatings with significantly improved surface quality.

In this study, friction and wear properties of MoS_2 coatings deposited by filtered Laser-Arc are studied as a function of the environment: in humid and dry air as well as in vacuum. As expected, significant wear rates and COF differences are observed under the used environmental conditions. Low friction with a coefficient of friction (COF) < 0.05 is found for the friction pair Steel / MoS_2 in a vacuum at 10^{-7} mbar. In dry conditions, the COF increases by a factor of approx. three, while in humid conditions, the COF increases by a factor of approx. nine. Raman studies reveal a complex structure evolution of MoS_2 in the wear track and on the contact area of the counter body with dry and humid conditions. In the contact areas, new unknown Raman lines appear after the experiment suggesting the material transformation, in particular, in the frequency range between 475 cm^{-1} and 1000 cm^{-1} that were not present in the pristine coating. Laterally and depth-resolved atomic insight in the transfer layer formation is obtained by microbeam Rutherford backscattering spectrometry and Raman mapping on the MoS_2 coatings and contact areas of steel counter bodies.

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Novel Mixed Dimensional Reconfigurable Field Effect Transistors: Fabrication and Characterization

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The physical downscaling of CMOS technology has reached its limitations. Subsequently, the quest for alternative technological solutions based on new materials and device concepts augment the downscaling of integrated circuits. One such concept is the reconfigurable FET (RFET), which can be dynamically programmed to n- or p-polarity by applying an electrostatic potential [1]. In this work, we present the idea of a novel mixed dimensional RFET device, which explores the potential of both one-dimensional (1D) channel materials (like silicon (Si) or silicon-germanium (SiGe) based nanowires) and two-dimensional (2D) materials. In the most generic process, an RFET device is based on intrinsic Si or SiGe nanowire with Nickel (Ni) placed on both ends. Subsequent annealing results in the formation of silicide regions in the nanowire. The junction of the silicide to Si or SiGe is a typical Schottky junction. By controlling the Schottky junction with the help of gating architectures, the flow of charge carriers within the channel can be modulated. For ambipolarity, an electrostatic potential on the back-gate or a single top-gate enables the n- or p-transport depending on the polarity of the gate voltage. The main aim of this work is to optimize the RFET architecture based on 2D materials like hexagonal boron nitride (hBN) as a dielectric and encapsulating layer instead of thermally grown oxide around the nanowire. 2D hBN comprises a structure very similar to graphene with its sub lattice consisting of boron or nitrogen atoms. However, contrary to graphene, hBN acts as an insulator with dielectric constant between 3-4 (similar to SiO_2). The properties of atomically thin hBN like the absence of dangling bonds, resistance to oxidation and chemical stability makes it an ideal gate dielectric material for flexible electronics.

Top-down fabrication of RFETs is an essential requirement for large-scale device integration. The Si or SiGe nanowires are fabricated using electron beam lithography and reactive ion etching [2]. As reported in our previous works, the formation of silicided Schottky junctions by flash lamp annealing (FLA) yields better control over the silicide progression in the nanowire compared to rapid thermal annealing (RTA) [3,4]. This work focuses on the application of 2D hBN as a dielectric layer for nanowire-based devices. The devices fabricated and characterized consist of a mechanically exfoliated 2D hBN flake deposited on the single Si or SiGe nanowire-based devices by the dry viscoelastic stamping transfer technique. The thickness of the hBN flakes, investigated by atomic force microscopy and transmission electron microscopy, was between 5-10 nm (shown in figure 1). The energy dispersive X-ray analysis (EDX) was also carried out on the cross-sectioned devices for investigating the elemental distribution (figure 2). The ambipolar transfer characteristics of the Si-hBN devices with different gating architectures (compared in figure 3) show a significant improvement in subthreshold swing value due to the 2D encapsulation and passivation. The fabricated SiGe-hBN based devices also show an improvement of p and n on-currents and I_{ON}/I_{OFF} ratio through back-gating due to the encapsulation and passivation of the nanowire by the hBN flake (figure 4).

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Effect of He^+ implantation on nanomechanical resonators in 3C-SiC

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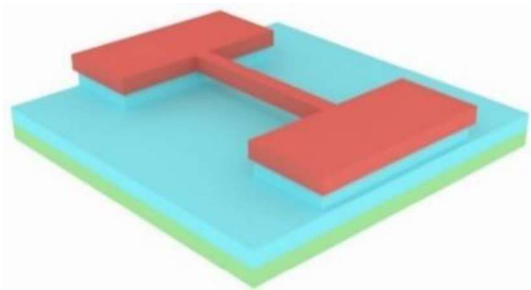

Silicon carbide (SiC) is a suitable candidate for Micro- and Nanoelectromechanical systems due to its superior mechanical properties. We would like to use it as a quantum sensor to sense small magnetic fields. It can be achieved by coupling a spin associated silicon vacancy (V_{Si}) in 4H-SiC with a mechanical mode of a resonator. Spin-mechanical resonance is observed when resonance frequency from V_{Si} matches resonance frequency of a mechanical mode.

In the initial experiments, we focus on the material modification by helium (He^+) ion broad beam implantation on a strained resonator based on 3C-SiC implanted with high fluence of ($1*10^{14}$ /cm^2) and low fluence ($1*10^{12}$ /cm^2) at 14 keV. The change in resonance frequency and quality factors as a function of fluence is studied. We also show the effect on stress and higher modes of the nanomechanical resonators.

Group IV Nanowires for Reconfigurable Field Effect Transistors

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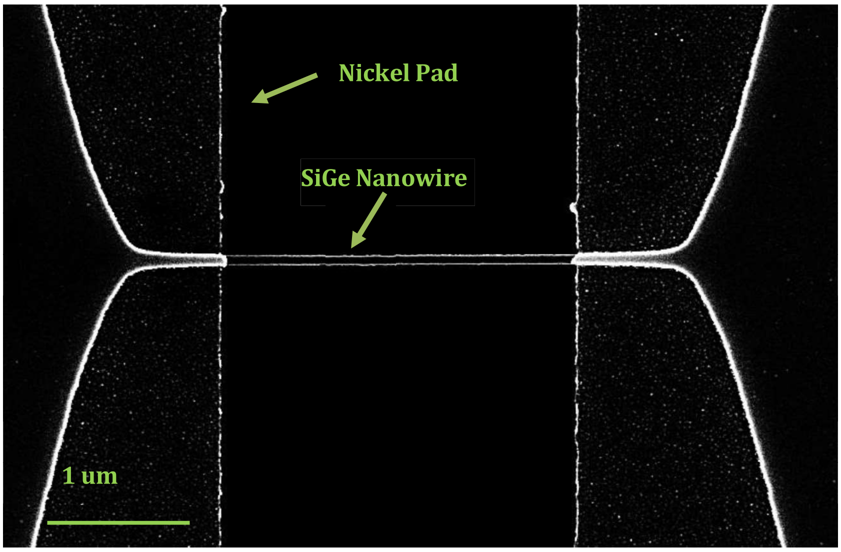
CMOS scaling is reaching physical limits in near future. Therefore, new approaches are required to continue achieving high speed and high performance devices. Replacing silicon with silicon-germanium alloy as a channel material having higher mobility contributes to faster and energy-efficient devices. In this work, we are investigating the transistor properties built from silicon germanium based nanowire channel. Schottky Barrier Field Effect Transistors are fabricated, which also have an additional functionality of re-configurability. This means that a single device can be operated as an N or P channel just by controlling the electric potential applied at the gate terminals [1]. The devices are fabricated by top-down approach with nickel metal pads on both sides of the silicon-germanium nanowire. To form schottky junctions, flash lamp annealing is performed to diffuse metal into the nanowires. The schottky junctions formed at the interface between nickel-germano-silicide and nanowire are electrically controlled to operate the device. Transfer characteristics of these devices are measured to investigate the transistor properties.



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Towards Atmospheric Radical Sensing: Fabrication of Junctionless Transistors

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Silicon nanowires, due to their high surface-to-volume ratio, have demonstrated energy-efficient devices. In this work, we report on the fabrication and electrical characterization of the junctionless nanowire transistor, a transistor consisting of a highly doped nanowire channel without p-n junctions, where the flow of carriers is controlled by the gate potential. To fabricate these transistors, intrinsic silicon-on-insulator (SOI) wafers were *n*-doped by ion implantation. Flash lamp annealing was performed for dopant activation and mitigation of implantation defects. Nanowires were fabricated following a top-down approach using electron beam lithography and reactive ion etching. Electrical characterization of the fabricated devices is performed by back-gating. The devices show an on/off current ratio of approx. 10^6. This will be followed by the functionalization of the fabricated devices for the selective and highly sensitive electrical detection of ·OH and $\cdot NO_3$ atmospheric radicals, which affect the air quality and climate and have a direct impact on our lives.

High-temperature in-air stable transparent conductive oxide SnO_2:Ta

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The transparent conductive tantalum doped tin oxide is a potential candidate for applications in concentrated solar power technology, dye-sensitized solar cells and dynamic random access memories [1], [2], [3]. In all these fields, high-temperature stability in air is mandatory to preserve its functionality. In this work we demonstrate the compositional and structural in-air-stability of SnO_2:Ta thin films at 650 °C and 800 °C for 12 hours. While the element composition and optical spectra were unchanged and the X-ray diffractograms revealed the conservation of a single-phase rutile-type crystal structure, some strong Raman lines of SnO_2:Ta underwent substantial changes upon tempering. Quantum ab initio calculations of pristine and Ta-doped SnO_2 with systematically varied point defects indicated that preferentially Sn vacancies and excess O atoms are responsible for these strong and unexpected Raman signatures. These defects are partially healed during high-temperature exposure, but that does not affect the functionality of SnO_2:Ta as transparent conductor under these harsh conditions. This study provides a comprehensive understanding of crystal and defect structure of Ta-doped SnO_2 prior to and after high temperature treatment in air for the first time and encourages its application in different fields where high-T stability, transparency and conductivity are required.

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On-chip room-temperature planar PIN Si:Te photodiodes for short-wavelength infrared detection

M.S. Shaikh[1,2], Mircea-Traian Catuneanu[2], Shuyu Wen[1,2], Mao Wang[3], Manfred Helm[1,2], Shengqiang Zhou[1], Kambiz Jamshidi[2], Yonder Berencén[1]

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Si hyperdoped with deep-level impurities is known for its strong photoresponse in the infrared region (IR) caused by the creation of an impurity band within the Si bandgap [1,2]. Room-temperature infrared p-n vertical photodetectors have been reported [3, 4]. Recently, it was proposed a planar design of an array of lateral p-i-n photodiodes based on hyperdoped Si that is compatible with very-large-scale integration (VLSI) Si technology [4]. In this work, we present the first experimental demonstration of a planar array of room-temperature infrared Te-hyperdoped photodetectors, which provides better performance compared to the state-of-the-art of hyperdoped Si p-n vertical photodetectors. These results hold promise for the integration of active and passive photonic elements in a single Si chip, making use of standard planar CMOS processes.

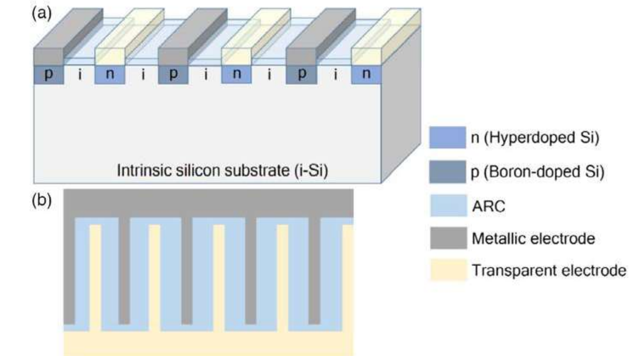

Figure1. a) cross-section of a proposed p-i-n photodetector with hyperdoped n region with transparent electrodes. b) top view showing the interdigitated contacts [4]

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Band-gap and strain engineering in $Ge_{1-x}Sn_x$ alloys using post-growth pulsed laser melting

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Alloying Ge with Sn enables effective band-gap engineering and improves significantly the charge carrier mobility. The pseudomorphic growth of $Ge_{1-x}Sn_x$ on Ge causes in-plane compressive strain, which degrades the superior properties of the $Ge_{1-x}Sn_x$ alloys. Therefore, efficient strain engineering is required. In this work, we will present strain and band-gap engineering in $Ge_{1-x}Sn_x$ alloys grown on a Ge virtual substrate using post-growth nanosecond pulsed laser melting (PLM). Micro-Raman spectroscopy and X-ray diffraction show that the initial in-plane compressive strain is removed. Moreover, for PLM energy densities higher than 0.5 J cm^{-2}, the $Ge_{0.89}Sn_{0.11}$ layer becomes tensile strained. Simultaneously, as revealed by Rutherford Backscattering spectrometry, cross-sectional transmission electron microscopy investigations, and X-ray diffraction, the crystalline quality and Sn-distribution in PLM-treated $Ge_{0.89}Sn_{0.11}$ layers are only slightly affected. Additionally, the change of the band structure after PLM is confirmed by low-temperature photoreflectance measurements. The presented results prove that post-growth ns-range PLM is an effective way for band-gap and strain engineering in highly-mismatched alloys.
This work was supported by the Bundesministerium für Bildung und Forschung (BMBF) under the project "ForMikro": Group IV heterostructures for high performance nanoelectronic devices (SiGeSn NanoFETs) (Project-ID: 16ES1075). We gratefully acknowledge the HZDR Ion Beam Centre for support.

Junctionless Nanowire Transistor based sensors for 'Atmospheric pollutants and detergents'

Vaishali Vardhan

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Air quality and climate change are among the biggest societal challenges that we face today. An estimated 7 million people globally die prematurely each year due to air pollution. Atmospheric free radicals, particularly hydroxyl (•OH) and nitrate (•NO_3), classified as atmospheric detergents, are the drivers of chemical processes. They determine the atmospheric composition and thus influence local and global air quality and climate. The ultimate aim of this project is to develop novel silicon junctionless nanowire transistor (Si JNT) sensors to detect hydroxyl and nitrate radicals. These JNT sensors are novel, low-cost, and easily accessible. JNTs will be functionalised with organic layers based on aromatics and alkanes with and without electron-withdrawing groups (*e.g.*, perfluorinated alkanes, ketones) for selectively trapping and sensing radicals.

Within this aim, to determine the suitability of Si JNT sensors in atmospheric sensing, initial tests were performed for different mixing ratios (ppb to ppm range) for the common atmospheric pollutant Nitrogen dioxide (NO_2). The adsorption of NO_2 molecules on Si-JNTs can lead to modulation of the concentration of holes and electrons in the conduction band of nanowires, resulting in a change in JNT parameters (e.g. on-current, mobility etc.), proving their sensitivity to gas environments. This presentation will provide an overview of the project on atmospheric radical sensing. Additionally, a summary of the latest results on the interaction of NO_2 and Si JNT will be presented. Although challenging, JNT sensors not only have the potential to be rolled out on a global scale but can also be adapted to detect both atmospheric pollutants such as Nitrogen dioxide and atmospheric detergents such as •OH and •NO_3.

Modification of two-dimensional materials using ion implantation

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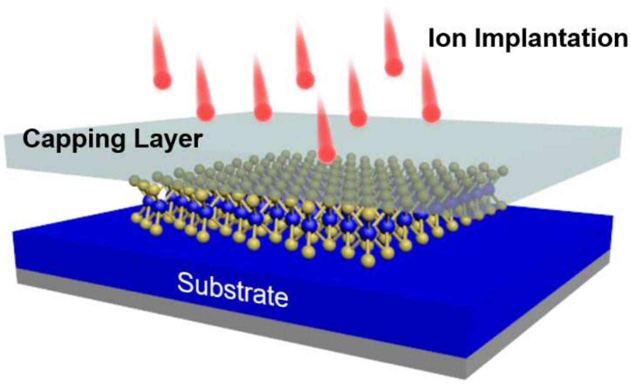
The optimum solution for future nano-(opto-)electronics is the integration of direct band gap semiconductors with current Complementary Metal-Oxide-Semiconductor (CMOS) technology. 2D semiconductors are amongst the most promising future semiconductors. Single layer transition metal dichalcogenides (TMDCs) with the general formula MX_2, where M = e.g. W or Mo and X=S, Se, or Te are characterized by direct bandgaps and high carrier mobilities. To realize low-power and high-performance electronic/optoelectronic devices based on 2D semiconducting TMDCs materials, several key parameters, such as contact resistance (R_C), channel/contact doping (n- or p-type), and charge carrier mobility (for both electrons and holes), need to be effectively engineered to harness the maximum intrinsic efficiency in the device. Up to now, the most common techniques does not provide stable and controllable doping that can be easily integrated with CMOS technology. Recently, we showed that efficient doping of a few layer thick $MoSe_2$ can be realized using Cl^+ ion implantation followed by sub-second annealing.[1] The successful doping of $MoSe_2$ was confirmed by I-V measurements and the red shift of the A_{1g} mode with increasing Cl concentration, which is due to the Fano interference caused by the coupling between discrete optical phonons and charge carriers.

Here, we extended our approach to the p-type and n-type doping in different TMDCs monolayer. $MoSe_2$ and WSe_2 monolayer, WS_2 monolayers are implanted through the energy filter with P or Cl ions to form p-type and n-type layers, respectively. Both the micro-Raman and PL spectroscopies shows that the monolayers of TMDCs can survive the implantation process and implanted elements are stopped within the layer. The successful ion doping will allow us to fabricate lateral homojunctions, which is a milestone for the integration of TMDCs with CMOS technology and the production of devices with diverse functionalities.



NanoNet+ Workshop 2022 - Görlitz

Posters

updated: 29.09.2022 (PZ)

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1) Posters should be mounted on arrival, and should be on display the whole time.
2) Please, remove your poster latest on Thursday noon.

Low Temperature β-Ga_2O_3 thin film employing CO_2 Laser and optimization of the annealing process.

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In this study, the rapid annealing process by employing CO_2 laser on β-Ga_2O_3 thin films and comparative analysis of the conversion of optical energy into thermal energy and physical properties were analyzed. After sol-gel and spin coating for 6 layer stacked, prepared thin film was irradiated by optimization Continuous Wave (CW) CO_2 laser (λ = 10.6 μm) with process time ranging from 30 to 60 seconds, Frequency for 5 kHz and output power for 30 Watt. By applying these experimental conditions, Crystallization of β-Ga_2O_3 was obtained and thermal annealing effect of 500 to 900 °C was measured by thermal imaging camera and modified optical-thermal transfer equation. The crystallinity of the thin film and surface morphology was examined by using X-ray diffraction (XRD) and Field emission scanning electron microscope (FE-SEM). And optical properties were confirmed using UV-vis spectrometer, Raman Spectra and Photo-luminescence (PL) spectrometer. Based on these results, reliability analysis was conducted through data matching using simulation program. Applying the MATLAB, we are modeling the Gaussian laser beam and calculating the simulation peak power and peak temperature with beam velocity. Furthermore, using the ANSYS, analyzed the optical annealing effect of moving heat source. Through the physical properties of β-Ga_2O_3 thin film measurement and comparative analysis process of simulation value and experiment value, the optical energy required for the crystallization of β-Ga_2O_3 and the optimized conditions for temperature prediction accordingly were confirmed and critical points of crystallization and destruction points were suggested.

Suppression of InGaN-based quantum-well indium desorption and Refinement of In–N During the Refined Temper Fire Treatment Process

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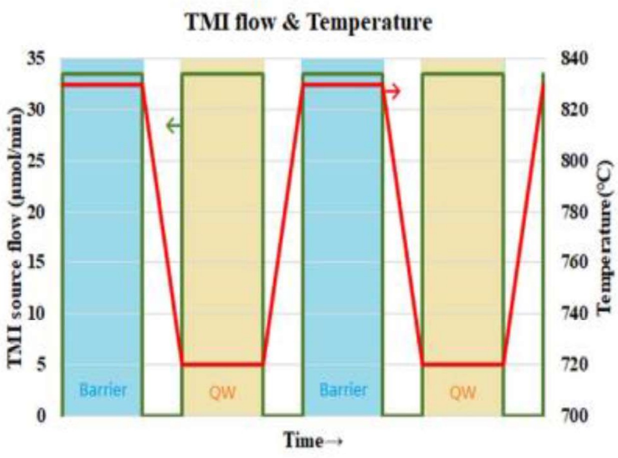
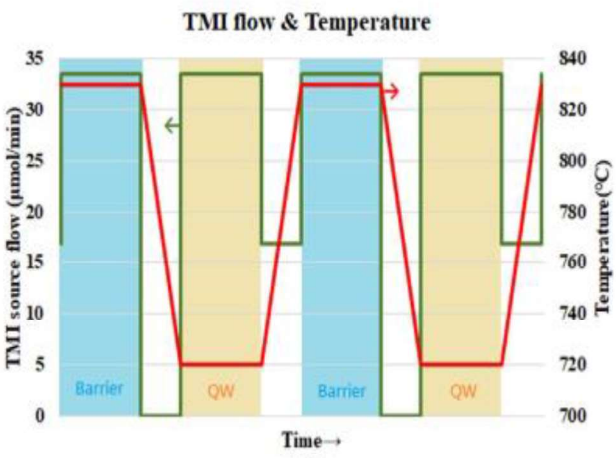
Abstract:

In this research, we investigate the indium desorption rate and describe a subtle method for refining the indium–nitrogen (In–N) re-bonding effect of InGaN by employing an indium post-flow during temper fire ($\Delta T = 110^{\circ}C$) treatment. This technique is, therefore, effective at improving the InGaN quality and compensating for the In–N bond desorption rate. We found that passing a sufficient indium amount during the temperature ramp not only can effectively suppress the indium desorption, but also can decrease the edge dislocation and improve the crystalline quality in the III-nitride nanostructure. The indium content in InGaN quantum wells (QWs) increased from 12.7 to 22.3% and the (102) epitaxy quality of InGaN improved. All the samples were grown on a c-plane sapphire substrate with multiple quantum-wells structure through the metal-organic vapor phase epitaxy (MOVPE) under atmospheric pressure, nitrogen (N2) was used as the carrier gas and triethylgallium (TEGa) and trimethylindium (TMIn) were used as the Ga and In precursors, respectively.



(a)



(b)

Ion-induced telecom single-photon emitters in silicon

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Single-photon emitters (SPEs) are one of the elementary building blocks for photonic quantum information and optical quantum computing [1]. One of the upcoming challenges is the monolithic photonic integration and coupling of single-photon emission, reconfigurable photonic elements, and single-photon detection on a silicon chip in a controllable manner. Particularly, fully integrated SPEs on-demand are required for enabling a smart integration of advanced functionalities in on-chip quantum photonic circuits [2]. The major challenge in realizing a fully monolithic, photonic integrated circuitry lies in the development of a quantum light source in silicon since the indirect nature of the small energy bandgap does not allow for efficient PL emission. Nevertheless, below-bandgap light emission can be used for good advantage by exploiting extrinsic and intrinsic point defects acting as SPEs. The isolation of SPEs, such as G-, W-, and T-centers, in the optical telecommunication O-band has recently been realized in silicon [3,4,5,6,7]. In all previous cases, however, SPEs were created uncontrollably in random locations, preventing their scalability.

This work presents mask-free nanofabrication involving a quasi-deterministic creation of single G- and W-centers in silicon wafers using focused-ion beam (FIB) writing. We also implement a scalable, broad-beam implantation protocol compatible with the complementary-metal-oxide-semiconductor (CMOS) technology to fabricate telecom SPEs at desired positions on the nanoscale [8]. Our findings unlock a clear and easily exploitable pathway for industrial-scale photonic quantum processors with technology nodes below 100 nm.

[1] D. D. Awschalom et al., Nature Photonics 12, 516 (2018)
[2] J. C. Adcock et al., IEEE, 27, 2, (2021)
[3] M. Hollenbach et al., Optics Express 28, 26111 (2020)
[4] W. Redjem et al., Nature Electronics, 3, 738–743 (2020)
[5] M. Prabhu et al., arXiv 2202.02342 (2022)
[6] Y. Baron et al., ACS Photonics, 9, 2337-2345, (2022)
[7] D. B. Higginbottom et al., Nature 607, 266–270 (2022)
[8] M. Hollenbach et al., arXiv:2204.13173 (2022)

Contact engineering of 2d materials through ion implantation and flash lamp annealing

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In recent years, 2D material-based nanodevices have been extensively studied and exhibit highly competitive performance compared with conventional bulk semiconductors. Before they can be fully integrated with existing Si-based technology or offer new platform for novel nanoelectronics, some challenges must be solved. One of the key challenges in 2D devices is the large Schottky barrier at the 2D/metal interface, which limits the charge carrier injection from metal to 2D channel. The doping techniques widely used in Silicon-based devices rarely work when applied to 2D materials, mainly due to the destruction of crystal lattice with introduced significant defect during the doping process, and technical problems with formation of ultra-low energy ion beams. In this paper, we propose a novel method, which exploits the top metal electrode as the capping layer during the ion implantation process, followed by ms-range flash lamp annealing to repair the defects caused by ion implantation and to activate dopants. Our approach allows to realize effective doping at the interface between multilayer 2D materials and metal electrodes and simultaneously minimize the defect concentration created during the ion implantation process. As a result, the ohmic contact between 2D material and metal electrodes will be realized.

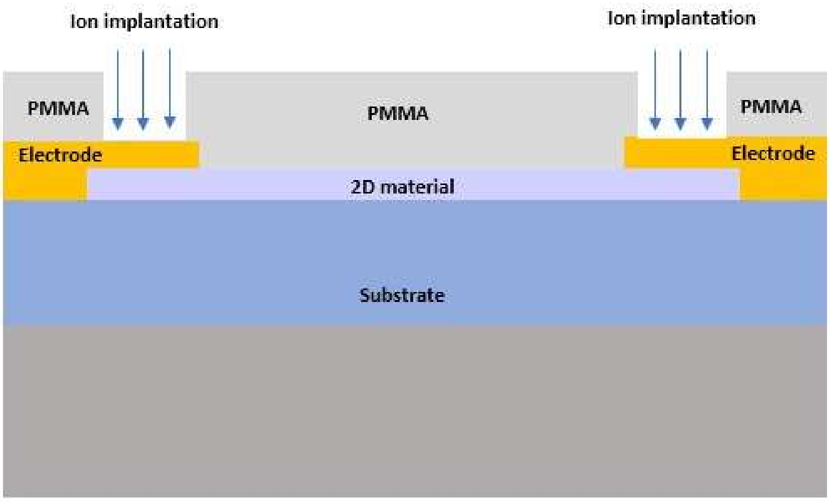

Figure 1 Ion implantation of two-dimensional materials with metal electrodes as capping layer

Evolution of electronic coupling in mechanically controllable break junctions

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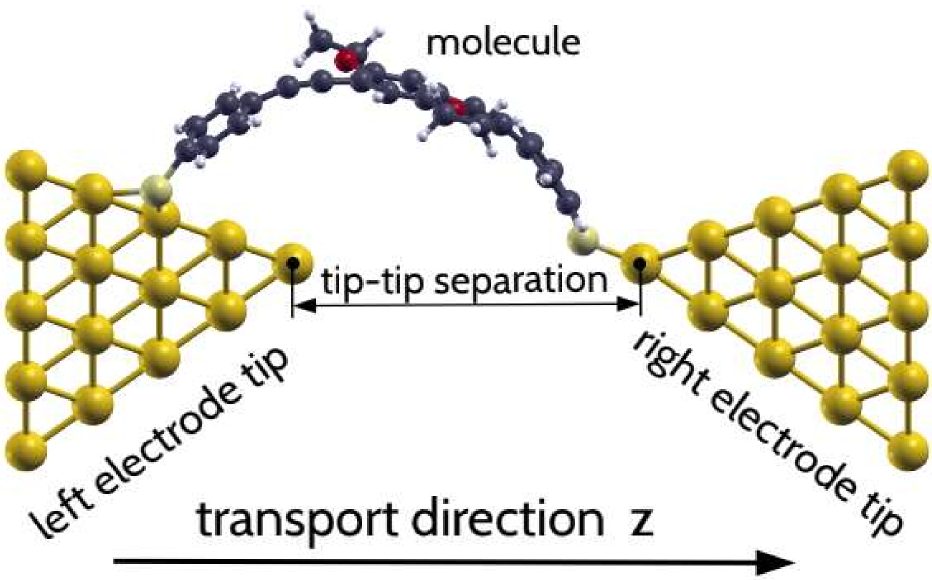
The electrical properties of single molecules can be investigated using atomically sharp metallic electrodes in mechanically controllable break junctions (MCBJs). The current-voltage (IV) characteristics of single molecules in such junctions are influenced by the binding positions of the end groups on the tip-facets and tip-tip separation. In this talk, we present MCBJ experiments on N,N'-Bis(5-ethynylbenzenethiol-salicylidene)ethylenediamine (Salen). We discuss the evolution of the single-level model (SLM) parameters namely, a) the energetic level ϵ of the dominant conducting channel, and b) the coupling Γ of the dominant conducting channel to the metallic electrodes. The SLM-parameters were evaluated for IV-curves recorded during opening measurements and fitted to the single-level model.
We propose a novel, high-throughput approach to model the evolution of the SLM-parameter. We explain the recurring peak-like features in the experimentally measured evolution of Γ with increasing tip-tip separation, which we relate to the deformation of the molecule and the sliding of the anchor groups across the electrode surface.



CrSBr: A new magnetic 2D material

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Abstract

In the recent decades, there is increasing interest for the combination of tunable electrical transport and spin configuration. Two-dimensional magnetic (2D) materials are a new platform to realize this, but are seriously limited by their air instability, low ordering temperatures and increasing thermal fluctuation with the size down to 2D. Here we present an air-stable 2D material CrSBr with strong anisotropy, showing an A-type anti-ferromagnetic structure with interlayer ferromagnetic order in each monolayer, and intralayer antiferromagnetic coupling along the stacking direction when below its Néel temperature, $T_N = 132 \pm 1$ K [1]. I will present the magnetic and structural properties of bulk CrSBr and the ion irradiation effect for few-layer thick CrSBr.

1. Telford, E. J., et al., Layered Antiferromagnetism Induces Large Negative Magnetoresistance in the van der Waals Semiconductor CrSbr. *Adv. Mater.* **2020**, *32*, 2003240.

Metallic nanowires assembled by DNA Origami

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In an effort to increase the processing power, electronic circuits look for new bottom-up strategies. Namely, DNA nanotechnology has shown valuable tools for the creation of nanostructures of arbitrary shape that can be used as templates.

Here we demonstrate the formation of 1D Au nanostructures based on DNA Origami templates, which are first formed by self-assembly and metallized in a subsequent step. DNA nanomolds are employed, inside which gold deposition is employed by site-specific attached seeds. During this step the walls of the nanomolds serve as constraints. To prove their metallic nature, top-down approach, allows us to perform temperature-dependent charge transport measurements along the nanostructures [1]. Transport through these assemblies is strongly nonlinear and shows a decrease in conductance towards low temperatures [2]. Thanks to the converging of both fabrication approaches, the shape of the nanowires can be controlled and measured. We use DNA-origami templates which are functionalized on their surface in order to create desired shapes of the metallic nanostructures and the nanoparticles show temperature dependent charge transport measurements reveal the dominating charge transport mechanisms along these wires [3].

[1] T. Bayrak, *et al.*, Nano Lett. **18**, 2116 (2018).

[2] J. Ye, *et al.*, Adv. Mater. **33**, 2100381 (2021).

[3] T. Bayrak, *et al.*, Scientific Reports **11**, 1922 (2021).

Investigation of Transport Phenomena Through Functionalized Single Molecules Using Liquid Mechanically Controllable Break Junctions

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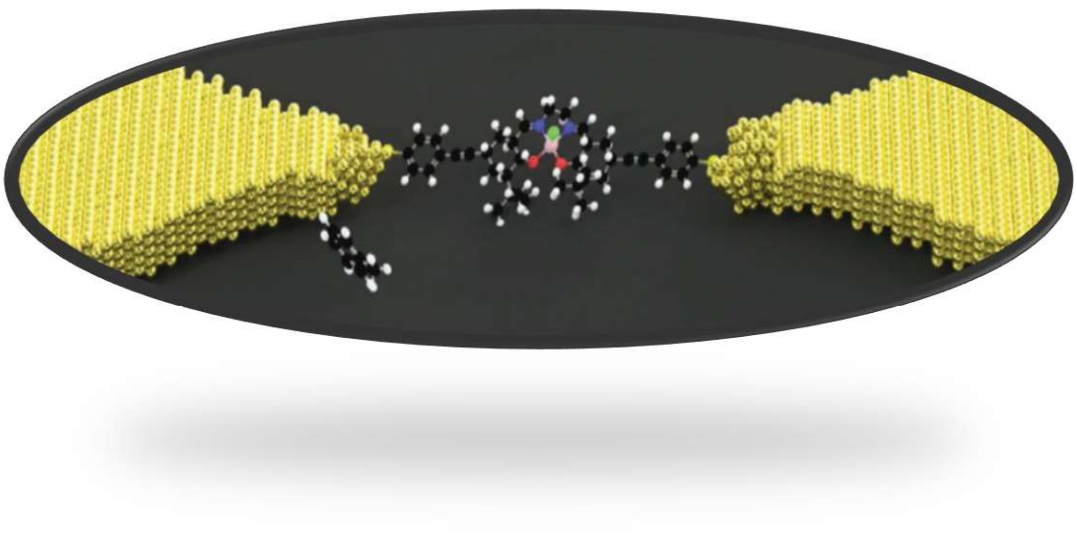
A great deal of progress has been made in the creation of molecular components that can be used as electronic components. It is necessary to develop techniques for controlling the modification of the conductivity of molecules contacted by metallic electrodes in order to advance the field toward realistic electronic concepts. It is presented here as a comprehensive study of charge transport in a class of molecules that can be modified by adding metal center/side chain groups to organic structures. To understand the role of metal center/side chain groups in the conductance mechanism through molecular junctions, single molecules are electrically contacted and characterized. In this study, it is demonstrated that the presence of single metal ions/side chain groups alters the energy levels and the coupling of molecules to the electrical contacts and that these changes result in systematic variations in the statistical behavior of molecular junction transport properties. To develop molecular electronic circuits, it is essential to understand the role that metal ions/side chains play in determining conductance properties. With the MCBJ technique, the junctions can be controlled slowly, sensitively, and reliably. Establishing molecular junctions that connect molecules to electrodes and exploring the charge transport behavior and electronic properties of molecular junctions are of key importance for conductance measurements.



Fabrication and Electronic Characterization of Germanium-Tin-on-insulator Junction–Less Nanowire Transistors

Oliver Steuer[1], Muhammad Moazzam Khan[1], Daniel Schwarz[2], René Hübner[1], Yordan Georgiev[1,3], Ciaran Fowley[1], Artur Erbe[1,4], Shengqiang Zhou[1], Slawomir Prucnal[1]

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Germanium-Tin ($Ge_{1-x}Sn_x$) alloys are promising CMOS-compatible materials to overcome the physical limits in the silicon-based process technology. $Ge_{1-x}Sn_x$ enables an effective band gap engineering, high carrier mobilities, and the possibility to combine optoelectronics and nanoelectronics on the same chip. Until now, it is challenging to find solutions to adjust existing CMOS-compatible process steps to overcome specific challenges of $Ge_{1-x}Sn_x$ alloys e.g. thermal stability, suitable contact formation methods, or a different chemical behavior. In this work, we present our first approaches for fabrication and results based on Junction-Less Nanowire Transistor (JNT) with a highly doped $Ge_{0.94}Sn_{0.06}$-on-Insulator layer fabricated by a top-down approach. The novel device concept of JNT´s allows us to simplify the fabrication process while at the same time making the transistor immune to doping induced short-channel effects.

This work was supported by the Bundesministerium für Bildung und Forschung (BMBF) under the project "ForMikro": Group IV heterostructures for high performance nanoelectronic devices (SiGeSn NanoFETs, Project-ID: 16ES1075).

Contact engineering of black phosphorus field-effect transistors

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Black phosphorus (BP) has recently emerged as new semiconducting two-dimensional (2D) material because of its unique properties such as tunable direct bandgap, high field-effect mobility, and good on/off ratio. In this work, we fabricated and characterized field-effect transistors (FETs) based on a few layers of black phosphorus, in order to evaluate the performance of devices using different contact materials like Graphene, Nickel (Ni), Titanium (Ti), and Chromium (Cr). We observed that the polarity and mobility value of transistors strongly depend on the contact material.

Strain engineering of Ge by ion irradiation and alloying

Shuyu Wen [1, 2], Li He [2], Oliver Steuer [1], Yonder Berencen [1], Slawomir Prucnal [1], Shengqiang Zhou [1 *]

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Germanium (Ge) is a traditional but promising material in integrated circuit (IC) due to the high mobility of hole carrier and highly compatibility in Si base-IC technology. However, the indirect band structure of Ge leading to low radiative recombination efficiency, limiting the application in opto-electronics. Strain engineering is a promising method to obtain energy band modification in semiconductors. Noble ions (He, Ar) are expected to induce tensile strain via bubbles formation or vacancy-related defect formation in Ge. A bubble-rich structure formation is accompanied by strongly amorphization process during 30 keV Ar^+ ions irradiation, while fully liquid-phase epitaxy is necessary to achieve a high-quality crystalline structure Fig.1 (A). 4 MeV He^+ ions irradiation in Ge can obtain a defect related tensile strain in Ge, which can be evaluated via Raman peak shift Fig.1 (B). IV-group heavy ions (Sn, Pb) alloying can lead a strong energy bandgap modification in Ge while the GeSn-alloy laser grown by RPCVD can work at low temperature. Here we use CMOS-compatible ion implantation to achieve a tensile GeSn alloy which shows a larger peak shift toward low wavenumber in Raman measurement Fig.1 (C). The photoconductivity detector based on $Ge_{0.97}Sn_{0.03}$ alloy shows a photo response to 1550 nm laser source Fig.1 (D).

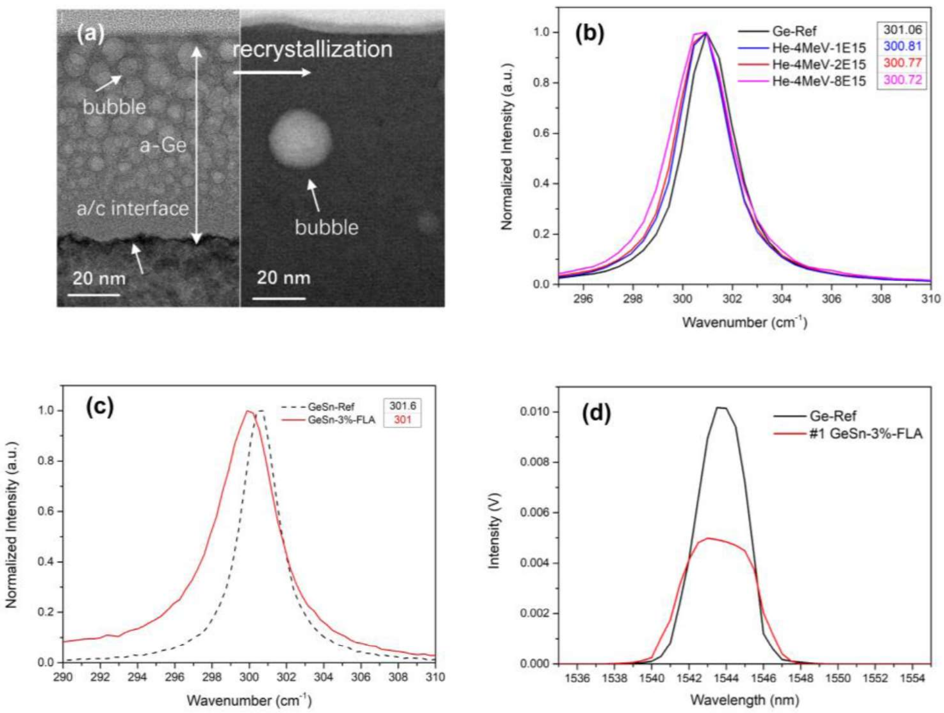

Fig.1

Flash lamp processing for superconducting Nb and its alloys

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Abstract

In recent years, the development of superconducting technology is focused mainly on finding new high temperature superconducting (SC) materials and their preparation process to meet the diversified requirements of applications. In this paper, we present a novel thermal process for innovative SC thin film coated cavities (using Nb and Nb-alloys) applying millisecond-flash-lamps. This unique, ultra-fast and low-energy-cost-treatment, being completely different from conventional annealing, will improve the crystalline quality, adhesion to the cavity and the SC performance of those films, and simultaneously suppresses the Cu-diffusion. The changes of superconducting behavior of different series of Nb and Nb-alloys are studied by SQUID-VSM. This work demonstrates that the ms-range annealing is sufficient to improve significantly the properties of superconducting materials. The high T_C coatings of superconducting cavities like Nb_3Sn films made with our technology will significantly reduce the environmental impact and energy-costs of SRF accelerator technology.

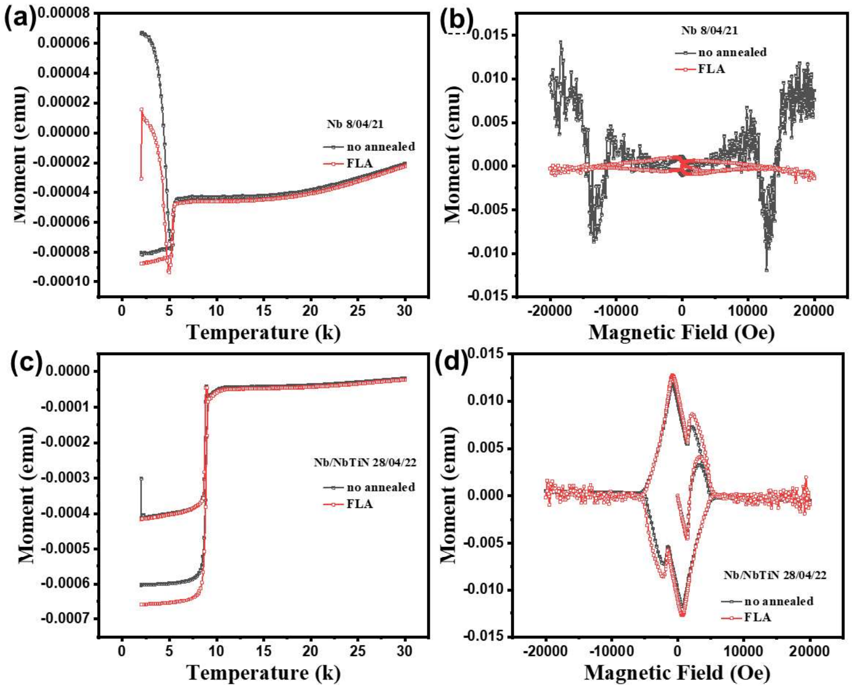

Figure. (a,c) Magnetization-temperature curves, and (b,d) hysteresis loops.

Photocatalytic one-step synthesis of Ag nanoparticles without reducing agent and their catalytic redox performance supported on carbon

Guoxiu Zhang[1], Lingling Shui[1], Bin Hu[2], Xingxing Chen[3], Mingliang Jin[1], Guofu Zhou[1,4,5], Nan Li[4], Martin Muhler[2,6], Baoxiang Peng[2,6]

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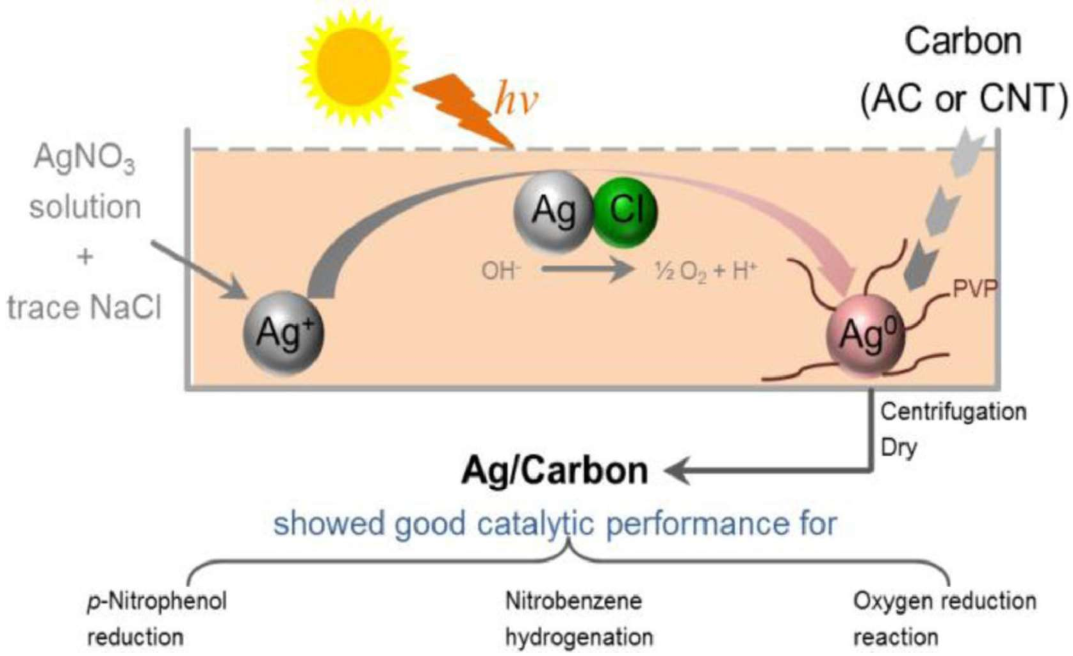
Abstract:
Synthesis of silver nanoparticles (Ag NPs) with state-of-the-art chemical or photo-reduction methods generally takes several steps and requires both reducing agents and stabilizers to obtain NPs with narrow size distribution. Herein, we report a novel method to synthesize Ag NPs rapidly in one step, achieving typical particle sizes in the range from 5 to 15 nm. The synthesis steps only involve three chemicals without any reducing agent: AgNO3 as precursor, polyvinylpyrrolidone (PVP) as stabilizer, and AgCl as photocatalyst. The Ag NPs were supported on carbon and showed excellent performance in thermal catalytic p-nitrophenol reduction and nitrobenzene hydrogenation, and as electrocatalyst for the oxygen reduction reaction.



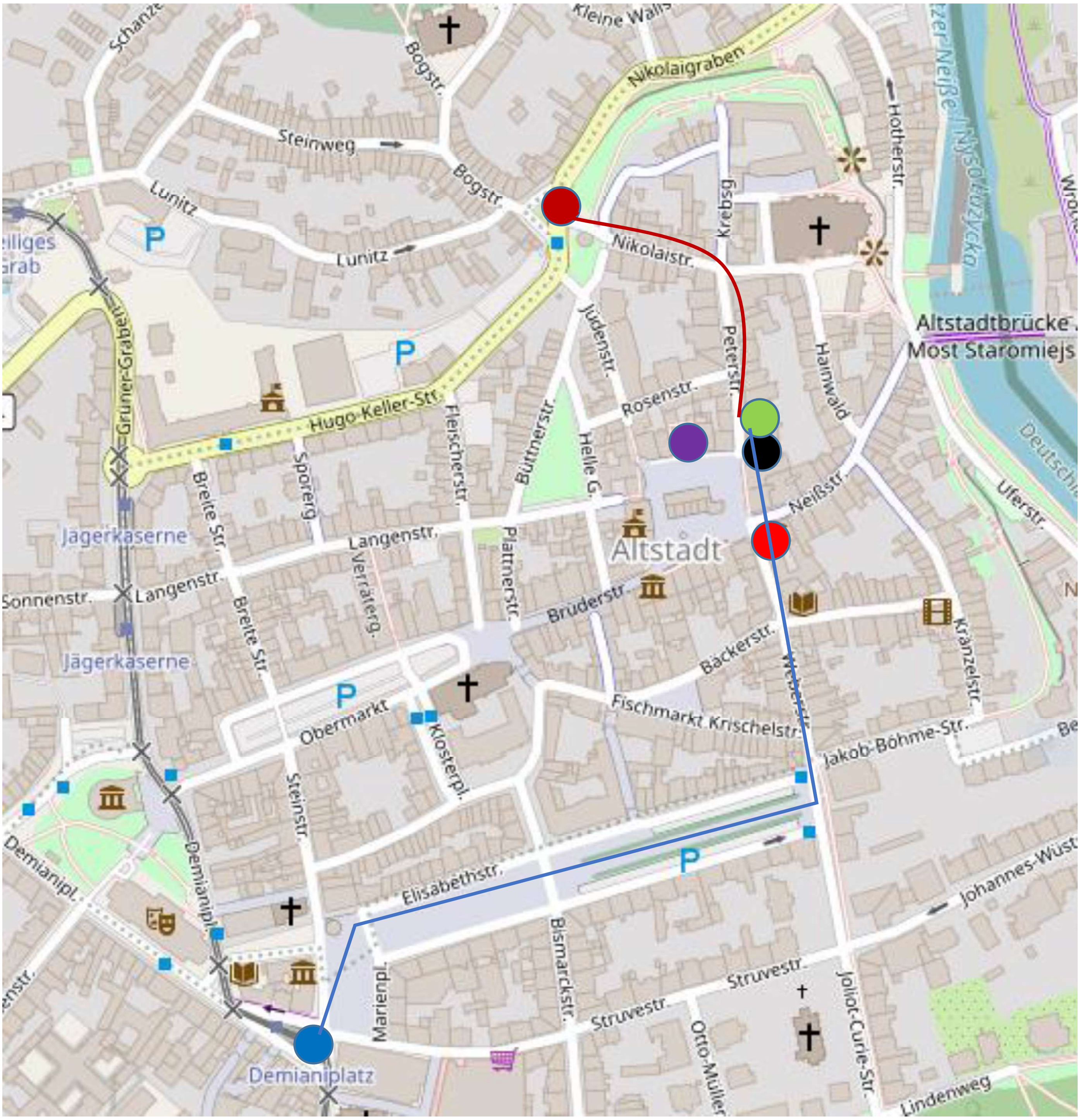
Your Notes

Your Notes

Görlitz Down Town

Bus Stop ‚Nikolaiturm‘

Youth Hostel (JH)



Tram Stop ‚Demianiplatz‘

Restaurant ‚Jonathan‘

Restaurant ‚Flüsterbogen‘

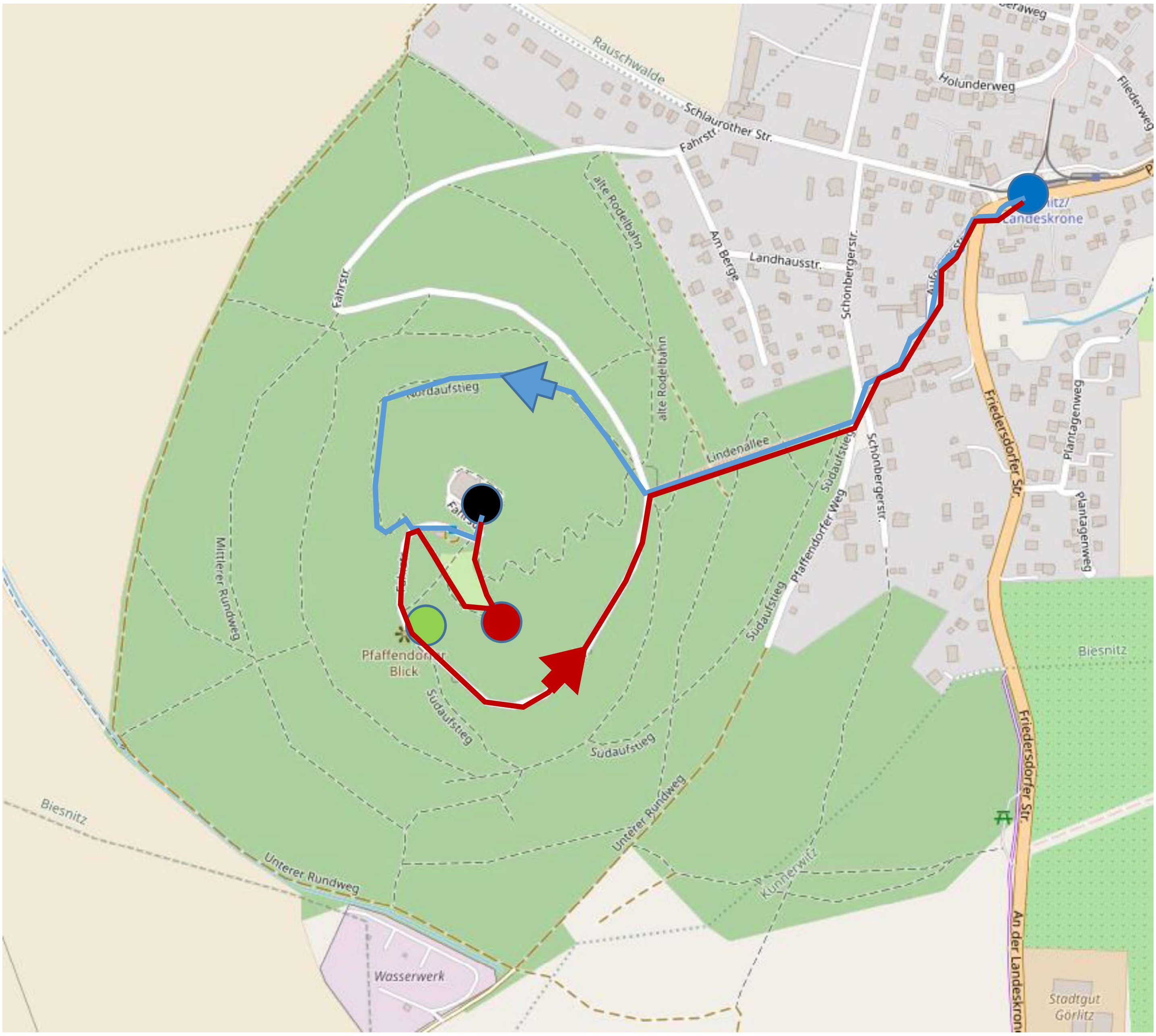
Museum Barock-Haus (Library)

Görlitz Landeskrone

Final Tram Stop ‚Biesnitz/Landeskrone‘:

Tram departure Demianiplatz 16:00 (sharp)

Start of Walking Tour ca. 16:20



Map © openstreetmap.de (2022)

Viewpoint ‚Landeskrone‘

Bismarck Monument

Nice view

Path up-hill in **Blue**, down-hill in **Red**.

Start of Down-hill Tour ca. 17:50

Tram departure to Demianiplatz: 18:23, ! BBQ Lunch at 19:00

NanoNet+ Workshop 2022 - Görlitz

Participants Updated: 29.09.2022 (PZ)

Name	First Name	Gender	Title	Institution
Bae	Minsung	Mr.		HZDR
Berencen	Yonder	Mr.	Dr.	HZDR
Biswas	Subhajit	Mr.	Dr.	Cork Univ Coll
Bratschitsch	Rudolf	Mr.	Prof.	Münster Univ.
Bussmann	Michael	Mr.	Dr.	CASUS
Chava	Phanish	Mr.		HZDR
Cheng	Henry Yu	Mr.		HZDR
Chennur	Madhuri	Ms.		HZDR
Echresh	Ahmad	Mr.		HZDR
Erbe	Artur	Mr.	Prof.	HZDR
Fekri	Zahra	Ms.		HZDR
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Frank	Otakar	Mr.	Prof.	CAS Prague
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Ghosh	Sayantan	Mr.		HZDR
Heinzig	Andre	Mr.	Dr.	TU Dresden
Hollenbach	Michael	Mr.		HZDR
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Khan	Bilal	Mr.	Dr.	HZDR
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Lambeva	Nikol	Ms.	Dr.	HZDR
Lin	Kaiman	Ms.		HZDR
Lokamani	Mani	Mr.		HZDR
Long	Fangchao	Mr.		HZDR
Prucnal	Slawomir	Mr.	Dr.	HZDR
Rebohle	Lars	Mr.	Dr.	HZDR
Rodriguez	Borja	Mr.		HZDR
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Sondhi	Harpreet	Mr.		HZDR
Steuer	Oliver	Mr.		HZDR
Vardhan	Vaishali	Ms.		Cork Univ Coll
Vekariya	Yagnika	Ms.		HZDR
Wen	Shuyu	Mr.		HZDR
Wu	Mei	Ms.		HZDR
Yi	Li	Mr.		HZDR
Zahn	Dietrich	Mr.	Prof.	TU Chemnitz
Zahn	Peter	Mr.	Dr.	HZDR
Zhang	Guoxiu	Ms.		HZDR
Zhou	Shengqiang	Mr.	Dr.	HZDR

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