Resonant dielectric structures are a promising platform for addressing the key challenge of light trapping in thin-film solar cells. Grandidier et al. (see pp. S58–S63 here) experimentally and theoretically demonstrate efficiency enhancements in solar cells from dielectric nanosphere arrays. Two distinct amorphous silicon photovoltaic architectures were improved using this versatile light-trapping platform. In one structure, the colloidal monolayer couples light into the absorber in the near-field acting as a photonic crystal light-trapping element. In the other, it acts in the far-field as a graded index antireflection coating to further improve a cell which already included a state-of-the-art random light-trapping texture to achieve a conversion efficiency over 11%.

Several researchers claim to have produced silicene, the graphene-like allotrope of silicon, that could result in the ultimate miniaturization of the Si-device technology and in novel electronic and optical properties due to the appearance of massless Dirac electrons. It is sometimes described as a new “wonder material”. Favored substrates are Ag(111) and Ir(111) metal surfaces. However, the growth of silicene layers is a huge challenge. Recent theoretical and experimental studies show a destruction of the Dirac cones due to a lowering of the honeycomb symmetry and the strong interaction with the substrate. In the Letter by Kokott, Matthes and Bechstedt (see pp. S25–S28 here) the possibility of the silicene formation on hydrogen-passivated Si(111) (as displayed on the front cover) and Ge(111) surfaces is predicted. The stability of a silicene sheet and its exceptional electronic properties are demonstrated by first-principles studies. The van-der-Waals interaction bonds the silicene layer to the inert substrates. Because of the reduced chemical interaction the linear conical bands near the corner points of the hexagonal Brillouin zone survive with an extremely small energy gap.

The focus of the paper by Riccardo Frisenda et al. (see pp. S101–S108 here) is the statistical analysis of breaking traces in single-molecule junctions. The cover image contains in the foreground an artistic impression of a molecular junction created with the mechanically controlled break junction (MCBJ) technique. The background features a picture of one of the MCBJ setups present in the authors’ laboratory. The MCBJ technique allows for the fast and reproducible creation of nanoelectrodes used to contact single molecules. By statistically analysing thousands of conductance traces and current-voltage characteristics it is possible to extract useful information about the electronic properties of single-molecule junctions.

Excellence – energy – ethics
Transport properties of Sb$_2$Te$_3$/Bi$_2$Te$_3$ topological insulator heterostructures

Zuocheng Zhang, Xiao Feng, Minghua Guo, Yunbo Ou, Jinsong Zhang, Kang Li, Lili Wang, Xi Chen, Qikun Xue, Xucun Ma, Ke He, and Yayu Wang


Zhang et al. fabricated topological insulator heterostructures consisting of p-type Sb$_2$Te$_3$ and n-type Bi$_2$Te$_3$ layers by using molecular beam epitaxy. Gate-tuned magnetotransport studies demonstrate the coexistence of electron- and hole-type charge carriers on the opposite surfaces of the heterostructure. This work paves the road for realizing the proposed exotic quantum phenomena that require opposite polarity of the surface Dirac fermions in topological insulator based structures.

Look fast: Crystallization of conjugated molecules during solution shearing probed in-situ and in real time by X-ray scattering

Detlef-M. Smilgies, Ruipeng Li, Gaurav Giri, Kang Wei Chou, Ying Diao, Zhenan Bao, and Aram Amassian


In this Letter, Smilgies and coworkers describe the first attempt of its kind to monitor in situ the solution-shearing process and thin film formation of the soluble small-molecule semiconductor TIPS-pentacene. The effects of shearing speed, blade–substrate gap as well as substrate temperature and solution concentration on the crystallization of the film are investigated in real time using microbeam grazing-incidence X-ray scattering and optical microscopy. The results point to processing conditions favorable to the formation of highly ordered and laterally oriented films.

Raman scattering and disorder effect in Cu$_2$ZnSnS$_4$


One of the most important challenges for the CZTS-type materials used for solar cells is nonstoichiometry. In this Letter, we investigate the relationship of antisite defects in the cation sublattice of CZTS with the peculiarities of its Raman spectra. The change of CZTS crystal symmetry from kesterite-type I4 to a disordered kesterite-type I42m manifests itself in a change of frequency and bandwidth of the main Raman A peak. This fact is discussed in the connection with disorder of Cu$^+$ and Zn$^{2+}$-ions on 2c and 2d sites in the crystalline lattice.
The authors present the first comprehensive experimental study on the dependence of carrier mobility on the layer thickness of multilayer MoS$_2$ field-effect transistors. They also propose a theoretical model based on Thomas–Fermi charge screening and interlayer coupling in order to explain their findings. Their model is extremely generic and can be applied to any two-dimensional layered system.

The growth of silicene, the graphene-like allotrope of silicon, is an unsolved challenge. As a favorable approach the silicene formation on a hydrogenated Si(111) or Ge(111) substrate is predicted. Its stability and electronic properties are demonstrated by first-principles studies.

To overcome the limitations of current III–V multi-junction solar photovoltaic (PV) cells, III–V nanowire-based PV is being aggressively pursued by numerous groups. This article provides a comprehensive review of nanowire-based PV covering all aspects of design for high power conversion efficiency including nanowire growth methods, growth direction, crystal structure, optical absorption, carrier collection, strain accommodation, tunnel junctions, Ohmic contact formation, passivation and doping.
Electrical transport in C-doped GaAs nanowires: surface effects

The resistivity and mobility of carbon-doped GaAs nanowires are studied for different doping concentrations. Surface effects have been evaluated by comparing unpassivated with passivated nanowires. At low doping concentrations the highest mobility is observed for unpassivated nanowires, while at higher doping concentrations the passivated nanowires offer the best characteristics. Electron beam induced current measurements show that the minority carrier diffusion path can be as high as 190 nm for passivated nanowires.

Low-thermal-conductivity group 13 chalcogenides as high-efficiency thermoelectric materials

Chalcogenides containing elements from group 13 have attracted attention as thermoelectric materials, particularly compounds with crystal structures derived from the diamond structure, such as zinc-blende and chalcopyrite structures. Specifically, a series of compounds that include CuGaTe₂, CuInTe₂, and AgGaTe₂ has been found to exhibit high thermoelectric figure of merit ($ZT$) values at high temperature. These chalcogenides are expected to attract increasing attention as novel thermoelectric materials and as the subject for investigating the mechanisms responsible for high $ZT$.

Solar cell efficiency enhancement via light trapping in printable resonant dielectric nanosphere arrays

Resonant dielectric structures are a promising platform for addressing the key challenge of light trapping in thin-film solar cells. Grandidier et al. experimentally and theoretically demonstrate efficiency enhancements in solar cells from dielectric nanosphere arrays. Two distinct amorphous silicon photovoltaic architectures were improved using this versatile light-trapping platform. In one structure, the colloidal monolayer couples light into the absorber in the near-field acting as a photonic crystal light-trapping element. In the other, it acts in the far-field as a graded index antireflection coating to further improve a cell which already included a state-of-the-art random light-trapping texture to achieve a conversion efficiency >11%.
**Editor's Choice**

Jun Liu, Jing Wang, Saijun Huang, Hsi-An Chen, and Gufeng He

**Improved efficiency of blue phosphorescence organic light-emitting diodes with irregular stepwise-doping emitting layers**


A stepwise doping emitting layer is considered as an effective way to control the charge transport and recombination in organic light-emitting diodes (OLEDs). It has been demonstrated that the irregular stepwise doping profile in the emitting layer can deliver better charge carrier balance and tune the recombination zone away from the low triplet energy electron transporting layer to avoid possible quenching. Both effects improve the efficiency significantly. It is anticipated that this method can also be applied to other emitting systems to realize better performance.

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**Advanced Materials Physics**

Masoud Dahmardeh, Mohamed Sultan Mohamed Ali, Tanveer Saleh, Tee Min Hian, Mehran Vahdani Moghaddam, Alireza Nojeh, and Kenichi Takahata

**High-power MEMS switch enabled by carbon-nanotube contact and shape-memory-alloy actuator**


A high-power micro-electro-mechanical switch is realized using a forest of vertically aligned carbon nanotubes (CNT) as contact material and a shape-memory-alloy (SMA) actuator. Large-force actuation of SMA enables vastly distributed contacts between the forest and the copper electrode, achieving low contact resistance and high current conduction. The contact material also shows varistor-like behavior. Long-term switching for over one-million cycles is demonstrated.

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**More to read in Phys. Status Solidi A**

Emil Petkov, Cyril Popov, Torsten Rendler, Christo Petkov, Florian Schnabel, Helmut Fedder, Sang-Yun Lee, Wilhelm Kulisch, Johann Peter Reithmaier, and Jörg Wrachtrup

**Investigation of NV centers in diamond nanocrystallites and nanopillars**


Color defects in diamond, especially nitrogen-vacancy (NV) centers, attract increasing interest due to their spin-controlled properties as a result of which applications in quantum information technology and magnetometry of single spins can be envisioned. Enhancement of the photon emission from NV centers and collection efficiency rely on their incorporation in optical structures, like photonic crystals, nanopillars, microrings, etc. Petkov et al. investigated NV centers incorporated during hot filament chemical vapor deposition of diamond nanocrystallites and nanocrystalline diamond (NCD) films.
**Editor's Choice**
Matthew J. Cliffe and Andrew L. Goodwin

Quantification of local geometry and local symmetry in models of disordered materials

Cliffe and Goodwin suggest two metrics for assessing the quality of configurations of disordered materials: namely, local geometric invariance and degree of local symmetry. These enable screening for structural simplicity in a way that does not rely on formal group theoretical language (and hence long-range periodic order). The authors show that various SiO2 and a-Si configurations are ranked sensibly by this approach, which is found to be significantly more sensitive to unphysical features than pairwise correlations.

**Editor's Choice**
Adisak Boonchun and Walter R. L. Lambrecht

Electronic structure of defects and doping in ZnO: Oxygen vacancy and nitrogen doping

While atomic nitrogen on the oxygen site in ZnO has too deep a level for p-type doping, a nitrogen molecule sitting on the Zn site is shown by means of first-principles calculations to have a shallow delocalized defect state suitable for p-type doping. The hyperfine structure and g-factor of the proposed N2 on Zn model are consistent with a previously observed Electron Paramagnetic Resonance center in ZnO.

**Statistical analysis of single-molecule breaking traces**
Riccardo Frisenda, Mickael L. Perrin, Hennie Valkenier, Jan C. Hummelen, and Herre S. J. van der Zant

Focus of this article is the statistical analysis of breaking traces in single-molecule junctions. The MCBJ (“mechanically controlled break junction”) technique used in the authors’ laboratory allows for the fast and reproducible creation of nanoelectrodes used to contact single molecules. By statistically analysing thousands of conductance traces and current–voltage characteristics it is possible to extract useful information about the electronic properties of single-molecule junctions.

**Luminescence and scintillation mechanism in Ce3+ and Pr3+ doped (Lu,Y,Gd)3(Ga,Al)5O12 single crystal scintillators**
M. Nikl, K. Kamada, S. Kurosawa, Y. Yokota, A. Yoshikawa, J. Pejchal, and V. Babin