NANOTECHNOLOGY

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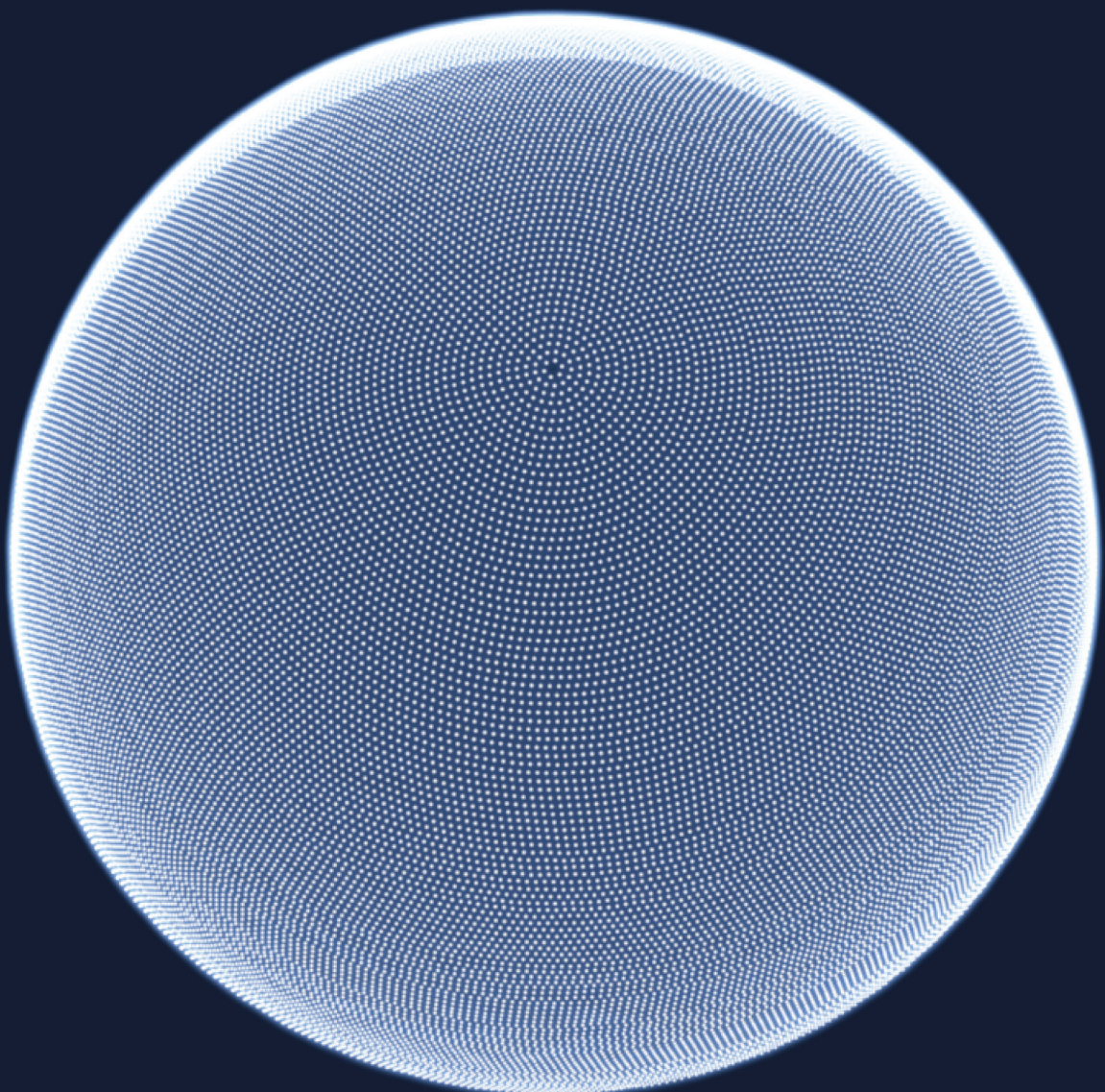
The **first journal** dedicated to nanoscale research presents some of the very best content published in 2016–2017.



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Foreword

Dear colleagues,

In 2016 we celebrated the 30th anniversaries of two technology milestones that arguably launched the field of nanoscale science. The Nobel Prize was awarded for scanning tunnelling microscopy in 1986, the same year as the first report of atomic force microscopy. Just a few years later, *Nanotechnology*™ launched – the first peer-reviewed journal in the world dedicated to the then emerging field.

To celebrate the anniversaries we ran a focus collection on some of the latest developments in two tools whose versatility has been applied in atomic scale manipulation, mechanical, electrical and chemical profiling, and disease diagnosis, to name a few. We also invited Guest Editors Franz Giessibl and Mervyn Miles from our Editorial Board and some authors from the collection to discuss the field's past and current research in a discussion webinar, still available from **iopscience.org/nano**.

The focus collection was just one of several that recently replaced our special issues as a more efficient way of collecting topical research in a timely way. This year we brought yet more speed to the delivery of our content: now, within a day of a paper being accepted, researchers will have access to a link to the raw paper while the production process to prepare the final publication is still under way.

Keep an eye out in 2017 for *Nano Futures*™, a new journal that shares much of the Editorial Board with *Nanotechnology* but which will be focusing on the kind of groundbreaking results that may be expected to shape the future of the field, just as *Nanotechnology* did in the early 1990s when the field first emerged. Take a look at **nano-futures.org** for more information.

Mark Reed
Editor-in-Chief, *Nanotechnology*
iopscience.org/nano
nano@iop.org

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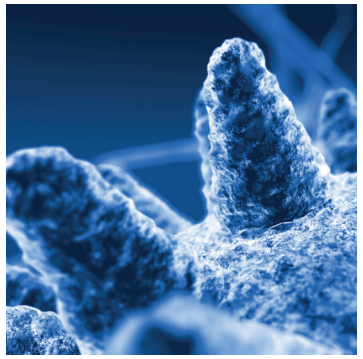
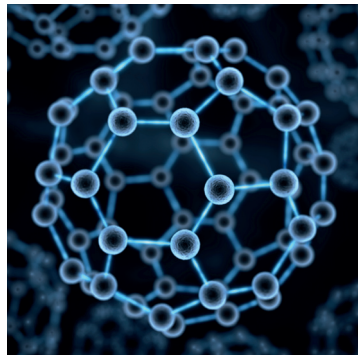
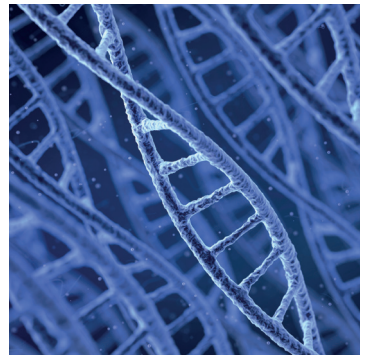

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Journal scope

IOP Publishing

3.573*

Impact Factor

*As listed in 2015 Journal Citation reports (Thomson Reuters 2016®)

1.75 million

***Nanotechnology* article downloads in 2016**

Nanotechnology publishes papers at the forefront of nanoscale science and technology, and especially those of an interdisciplinary nature. Nanotechnology is taken to include the ability to individually address, control and modify structures, materials and devices with nanometre precision, as well as the synthesis of such structures into systems of micro- and macroscopic dimensions such as MEMS-based devices. It encompasses the understanding of the fundamental physics, chemistry, biology and technology of nanometre-scale objects and how such objects can be used in the areas of computation, sensors, nanostructured materials and nano-biotechnology.

To be published in this journal, papers must meet the highest scientific quality standards, should contain significant and original new science, and make substantial advances within a particular area of nanoscale science and technology.

- **Research papers**
  Are reports of original work, categorised by four different journal sections
- **Focus collections**
  Diverse selections of primarily invited articles, each serving to highlight work in areas of current scientific interest, as identified by the Editorial Board.
- **Letters**
  Outstanding short papers reporting new and timely developments in nanotechnology, given accelerated publication by the journal.
- **Topical reviews**
  Review articles commissioned by the Editorial Board that provide a snapshot of recent progress in a particular field.
- **Perspectives**
  Commentaries aimed at highlighting the significance, impact and wider implications of research appearing in *Nanotechnology*.

Papers published in 2016

Nanotechnology research papers are separated into seven separate journal sections, reflecting the scope and content of the journal.

32%

Materials: properties, characterization or tools
Features the measurement of properties intrinsic to the nanoscale, and those techniques devised to characterize materials at this scale. This section also contains articles concerned with the understanding and prediction of properties through theoretical and computer modelling.

17%

Electronics and photonics
Includes papers on materials, fabrication technologies and applications for nanodevices, novel electronic and photonic phenomena and systems in the mesoscopic and nanoscale regimes. The section also includes aspects of quantum science and technology.

16%

Materials: synthesis or self-assembly
Concerns the fabrication and growth of materials with nanoscale precision and control. Papers in this section should include direct material synthesis and characterization, but focus in addition upon methodology, assembly or application directed synthesis.

11%

Patterning and nanofabrication
Focuses on novel processing methods with nanometre resolution. Topics encompass a wide range of patterning and nanolithography techniques, including the assembly of inorganic and organic nanomaterials, and electron and ion beam nanopatterning.

10%

Energy at the nanoscale
Applications and fundamental science of nanotechnology in developing energy resources, including photovoltaics, batteries, fuel cells, hydrogen generation and storage, supercapacitors, photoelectrochemical cells and thermoelectrics.

7%

Biology and medicine
Focuses on novel processing methods with nanometre resolution. Topics encompass a wide range of patterning and nanolithography techniques, including the assembly of inorganic and organic nanomaterials, and electron and ion beam nanopatterning.

7%

Sensing and actuating
Covers a range of detection methods sensitive at the nanoscale that are able to convey and enhance information to the macroscopic scale for a wide range of applications, from gas, electrochemical and biosensing, to optical, mechanical and pressure sensing.

Nanotechnology Young Researcher Award 2016

Following the success of the first Young Researcher Award in 2015, *Nanotechnology* again invited nominations for this award recognising early career brilliance, open to PhD students and researchers within the first five years of completing their PhD.

Dr Stephan Wirths
IBM Research Lab, Zürich

We received more than 190 nominations for the award this year, and the standard of entries has been extremely impressive. We are pleased to announce that the winner of the 2016 Young Researcher Award is **Dr Stephan Wirths**, currently working at the **IBM Research Lab**, Zürich, for his work on achieving an indirect-to-direct band-gap transition in group-IV semiconductors through alloying Ge with Sn. This new material system enables ultra-low-power nanoelectronics as well as efficient light emission, and monolithically integrated, direct-band gap-group-IV laser sources along with mature CMOS technology could be key for future electronic-photonic integrated circuits (EPICs) with optical instead of electronic interconnects for on-chip and/or chip-to-chip data transfer.

Also highly commended are the runners-up for the prize:

- **Dr Qiao Zhang**, Soochow University, Jiangsu
- **Dr Dustin Gilbert**, National Institute of Standards and Technology, USA

To read a full interview with the winner of the Young Researcher Award 2016, visit **nanotechweb.org**.

Outstanding Reviewer Award 2016

Dr Adriano Cola
Consiglio Nazionale delle Ricerche, Italy

This year, *Nanotechnology* launched the Outstanding Reviewer Award to recognise its top reviewers in terms of quality of service and speed of reporting throughout the year. From among these, one overall winner is chosen for their outstanding contribution to *Nanotechnology*.

We are delighted to announce that **Dr Adriano Cola** of the **Consiglio Nazionale delle Ricerche, Italy** has been selected as the *Nanotechnology* Reviewer of 2016. Dr Cola was selected for his contribution of a significant number of consistently high-quality and thorough reviews throughout 2016.

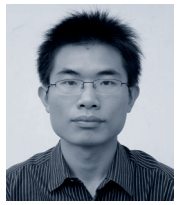
Peer review forms the backbone of scholarly communication, providing essential rigour and validation for published papers in *Nanotechnology*. The editorial team therefore wishes to thank its reviewers who provide this valuable service and help to ensure the journal's high quality standards.

For a full list of top referees nominated this year, please visit **iopscience.org/nano**.

Research papers

Nanotechnology publishes papers at the forefront of nanoscale science and technology, and especially those of an interdisciplinary nature. Submissions should contain significant and original new science, and make a substantial advance in the field.

Yong Wei Zhang
Institute of High Performance Computing, A*STAR, Singapore



Yongqing Cai
Institute of High Performance Computing, A*STAR, Singapore

Substitutionally doped phosphorene: electronic properties and gas sensing

Nawat Suvansinpan, Fayyaz Hussain, Gang Zhang, Cheng Hsin Chiu, Yongqing Cai and Yong-Wei Zhang
2016 *Nanotechnology* **27** 065708

Abstract

Phosphorene, a new elemental two-dimensional material, has attracted increasing attention owing to its intriguing electronic properties. In particular, pristine phosphorene, due to its ultra-high surface–volume ratio and high chemical activity, has been shown to be promising for gas sensing (Abbas *et al* 2015 *ACS Nano* **9** 5618). To further enhance its sensing ability, we perform first-principles calculations based on density functional theory to study substitutionally doped phosphorene with 17 different atoms, focusing on structures, energetics, electronic properties and gas sensing. Our calculations reveal that anionic *X* (*X* = O, C and S) dopants have a large binding energy and highly dispersive electronic states, signifying the formation of covalent *X*–P bonds and thus strong structural stability. Alkali atom (Li and Na) doping is found to donate most of the electrons in the outer s-orbital by forming ionic bonds with P, and the band gap decreases by pushing down the conduction band, suggesting that the optical and electronic properties of the doped phosphorene can be tailored. For doping with VIIIB-group (Fe, Co and Ni) elements, a strong affinity is predicted and the binding energy and charge transfer are correlated strongly with their electronegativity. By examining NO molecule adsorption, we find that these metal doped phosphorenes (MDPs) in general exhibit a significantly enhanced chemical activity compared with pristine phosphorene. Our study suggests that substitutionally doped phosphorene shows many intriguing electronic and optic properties different from pristine phosphorene and MDPs are promising in chemical applications involving molecular adsorption and desorption processes, such as materials growth, catalysis, gas sensing and storage.

Sunayna Bashar
University of California, Riverside

Jianlin Liu
University of California, Riverside

Hyun Wook Kang
Pukyong National University

Junghwan Oh
Pukyong National University

An Sb-doped p-type ZnO nanowire based random laser diode

Sunayna B Bashar, Mohammad Suja, Muhammad Morshed, Fan Gao and Jianlin Liu
2016 *Nanotechnology* **27** 065204

Abstract

An electrically pumped Sb-doped ZnO nanowire/Ga-doped ZnO p–n homojunction random laser is demonstrated. Catalyst-free Sb-doped ZnO nanowires were grown on a Ga-doped ZnO thin film on a Si substrate by chemical vapor deposition. The morphology of the as-grown titled nanowires was observed by scanning electron microscopy. X-ray photoelectron spectroscopy results indicated the incorporation of Sb dopants. Shallow acceptor states of Sb-doped nanowires were confirmed by photoluminescence measurements. Current–voltage measurements of ZnO nanowire structures assembled from p- and n-type materials showed a typical p–n diode characteristic with a threshold voltage of about 7.5 V. Very good photoresponse was observed in the UV region operated at 0 V and different reverse biases. Random lasing behavior with a low-threshold current of around 10 mA was demonstrated at room temperature. The output power was 170 nW at 30 mA.

In vitro study on apoptotic cell death by effective magnetic hyperthermia with chitosan-coated $MnFe_2O_4$

Yunok Oh, Nohyun Lee, Hyun Wook Kang and Junghwan Oh
2016 *Nanotechnology* **27** 115101

Abstract

Magnetic nanoparticles (MNPs) have been widely investigated as a hyperthermic agent for cancer treatment. In this study, thermally responsive Chitosan-coated $MnFe_2O_4$ (Chitosan-$MnFe_2O_4$) nanoparticles were developed to conduct localized magnetic hyperthermia for cancer treatment. Hydrophobic $MnFe_2O_4$ nanoparticles were synthesized via thermal decomposition and modified with 2,3-dimercaptosuccinic acid (DMSA) for further conjugation of chitosan. Chitosan-$MnFe_2O_4$ nanoparticles exhibited high magnetization and excellent biocompatibility along with low cell cytotoxicity. During magnetic hyperthermia treatment (MHT) with Chitosan-$MnFe_2O_4$ on MDA-MB 231 cancer cells, the targeted therapeutic temperature was achieved by directly controlling the strength of the external AC magnetic fields. *In vitro* Chitosan-$MnFe_2O_4$-assisted MHT at 42°C led to drastic and irreversible changes in cell morphology and eventual cellular death in association with the induction of apoptosis through heat dissipation from the excited magnetic nanoparticles. Therefore, the Chitosan-$MnFe_2O_4$ nanoparticles with high biocompatibility and thermal capability can be an effective nano-mediated agent for MHT on cancer.

Introducing *Nano Futures*

We are designing Nano Futures to become the benchmark of nanoscience research now and into the future. Publishing urgent work that truly sets the direction of new and emerging fields, our priority is to combine high-impact content with high-impact author service.

Mark Reed, Editor-in-Chief

nano-futures.org

Nano Futures™ is a multidisciplinary journal devoted to publishing original research of the highest quality and impact in the most cutting-edge areas of nanoscience and related technologies. Highly selective, the journal's main aim is to become the home for high-urgency work that will define the future direction of new and emerging fields across nanoscience.

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- Accepted articles available online within 24 hours
- Article-specific promotion to maximise visibility and impact
- Wider media coverage through IOP Publishing's award-winning journalistic service

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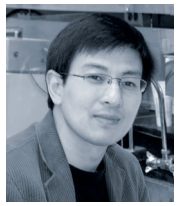
Cover image: Inspired by schematic of a 3D-printed prototype of graphyne, a synthetic carbon allotrope of carbon, that was designed using category theory **Dieter B Brommer *et al*** 2016 *Nanotechnology* **27** 024002.

Letters

Outstanding short articles reporting new and timely developments in nanotechnology, Letters benefit from faster publication times and a dedicated section in the journal.

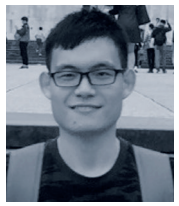


Xuping Sun
China West Normal University

Amorphous Ni-B alloy nanoparticle film on Ni foam: rapid alternately dipping deposition for efficient overall water splitting

Yanhui Liang, Xuping Sun, Abdullah M Asiri and Yuquan He
2016 *Nanotechnology* **27** 12LT01

Abstract
It is highly attractive, but still remains challenging, to develop noble metal-free bifunctional electrocatalysts efficient for both the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) in alkaline media. In this letter, we describe the rapid electroless deposition of amorphous Ni-B nanoparticle film on Ni foam (Ni-B/Ni foam) by alternative dipping of Ni foam into Ni precursor and reducing solutions. This Ni-B/Ni foam acts as an efficient and durable 3D catalytic electrode for water splitting, affording 100 mA cm^{-2} at 360 mV overpotential for the OER and 20 mA cm^{-2} at 125 mV overpotential for the HER in 1.0 M KOH, and its two-electrode electrolyzer demands a cell voltage of 1.69 V to afford 15 mA cm^{-2} water-splitting current. Moreover, the catalyst loading can be easily tuned and this alternately dipping deposition technique works universally for other conductive substrates.



Jian Huang
University of Science and Technology of China

Bin Xiang
University of Science and Technology of China

Stable electrical performance observed in large-scale monolayer $WSe_{2(1-x)}S_{2x}$ with tunable band gap

Jian Huang, Wenhui Wang, Qi Fu, Lei Yang, Kun Zhang, Jingyu Zhang and Bin Xiang
2016 *Nanotechnology* **27** 13LT01

Abstract
Two-dimensional (2D) semiconductor materials have attracted broad interest due to their unique structures and physical properties. The stability of the 2D-material-based devices plays a key role in their practical applications. Here, we report the promising stable electrical performance in the large-scale monolayer $WSe_{2(1-x)}S_{2x}$ with a tunable band gap. Photoluminescence (PL) spectroscopy was utilized to verify the tunable band gap in the as-grown monolayer with a tuning capability of 120 meV. Gated field effect transistor (FET) performance confirmed the p-type transport behavior in monolayer $WSe_{2(1-x)}S_{2x}$ with a high on/off ratio (>10^4). Top-gated FET configuration improves the carrier mobility with two orders larger than that in the back-gated FET device. After exposure to air for three months, the device performance manifested excellent stability with no source-drain current drop observed. P-type $WSe_{2(1-x)}S_{2x}$ with a tunable band gap is the ideal complement to n-type tunable monolayers in the application of pn junction-related flexible nanodevices.

Topical reviews

The Editorial Board regularly identifies fields of current interest and commissions reviews in these areas. These reviews provide a brief overview of a rapidly developing field and aim to be interesting and informative for a broad scientific readership.

Minoru Fujii
Kobe University

Hiroshi Sugimoto
Kobe University

All-inorganic colloidal silicon nanocrystals—surface modification by boron and phosphorus co-doping

Minoru Fujii, Hiroshi Sugimoto and Kenji Imakita
2016 *Nanotechnology* **27** 262001

Abstract
Si nanocrystals (Si-NCs) with extremely heavily B- and P-doped shells are developed and their structural and optical properties are studied. Unlike conventional Si-NCs without doping, B and P co-doped Si-NCs are dispersible in alcohol and water perfectly without any surface function-alization processes. The colloidal solution of co-doped Si-NCs is very stable and no precipitates are observed for more than 5 years. The co-doped colloidal Si-NCs exhibit size-controllable photoluminescence (PL) in a very wide energy range covering 0.85 to 1.85 eV. In this paper, we summarize the structural and optical properties of co-doped Si-NCs and demonstrate that they are a new type of environmentally-friendly nano-light emitter working in aqueous environments in the visible and near infrared (NIR) ranges.

Di Zhang
Shanghai Jiao Tong University

Shenmin Zhu
Shanghai Jiao Tong University

Bio-inspired fabrication of stimuli-responsive photonic crystals with hierarchical structures and their applications

Tao Lu, Wenhong Peng, Shenmin Zhu and Di Zhang
2016 *Nanotechnology* **27** 122001

Abstract
When the constitutive materials of photonic crystals (PCs) are stimuli-responsive, the resultant PCs exhibit optical properties that can be tuned by the stimuli. This can be exploited for promis-ing applications in colour displays, biological and chemical sensors, inks and paints, and many optically active components. However, the preparation of the required photonic structures is the first issue to be solved. In the past two decades, approaches such as microfabrication and self-assembly have been developed to incorporate stimuli-responsive materials into exist-ing periodic structures for the fabrication of PCs, either as the initial building blocks or as the surrounding matrix. Generally, the materials that respond to thermal, pH, chemical, optical, electrical, or magnetic stimuli are either soft or aggregate, which is why the manufacture of three-dimensional hierarchical photonic structures with responsive properties is a great chal-lenge. Recently, inspired by biological PCs in nature which exhibit both flexible and responsive properties, researchers have developed various methods to synthesize metals and metal oxides with hierarchical structures by using a biological PC as the template. This review will focus on the recent developments in this field. In particular, PCs with biological hierarchical structures that can be tuned by external stimuli have recently been successfully fabricated. These findings offer innovative insights into the design of responsive PCs and should be of great importance for future applications of these materials.

Focus collections

Our focus collections comprise a diverse selection of exclusive articles, each serving to highlight exciting work conducted in active areas of particular current interest. Leading researchers act as Guest Editors for these high-impact focus collections. Just some of the ongoing focus collections are listed below.

Hierarchical nanostructures

Guest Editors: Markus Buehler and Zhao Qin

Advanced manufacture techniques can now precisely control the nanoscale feature of small molecules, but the astounding ability of natural materials to integrate disparate properties, and multiple length-scales, goes far beyond our current ability in designing and synthesizing materials. This special issue will explore scientific advances at this frontier, and explore the analysis, design and making of new functional materials.

Organic LEDs

Guest Editors: Lei Ying and Junbiao Peng

This focus collection covers new LED materials, OLED technology, device concepts, processing techniques and quantum-dot OLEDs.

Protein folding

Guest Editors: Jorge Alegre-Cebollada, Sergi Garcia-Manyes and Raul Perez-Jimenez

This focus collection features research that covers the subject area of protein folding: the means by which a protein chain acquires its native three-dimensional configuration. We welcome articles that present information regarding protein-folding mechanisms, folding and unfolding rates, kinetics and structure.

Inorganic semiconductor nanowires for device applications

Guest Editors: Adam Micolich, Ming Li and Philippe Caroff

This focus collection is devoted to canvassing recent progress on the growth, fabrication, characterisation and applications development of device-oriented structures that use inorganic semiconductor nanowires of various compositions from elemental semiconductors.

For a full list of ongoing focus collections, visit
iopscience.org/nano/focus-collections

Focus-collection highlights

Shengli Zhang
Nanjing University of Science and Technology

Haibo Zeng
Nanjing University of Science and Technology

FOCUS ON 2D MATERIALS BEYOND GRAPHENE

Two-dimensional GeS with tunable electronic properties via external electric field and strain

Shengli Zhang, Ning Wang, Shangguo Liu, Shiping Huang, Wenhan Zhou, Bo Cai, Meiqiu Xie, Qun Yang, Xianping Chen and Haibo Zeng
2016 *Nanotechnology* **27** 274001

Abstract
Recently, GeS monolayer, the isoelectronic counterpart of phosphorene, has attracted much attention due to promising properties. Haibo Zeng, Nanjing University of Science and Technology, China, and colleagues have studied the stability and electronic properties of GeS monolayer by first-principles calculations. Especially, external electric field and in-plane strain were used to tailor its electronic band gap. Upon applying electric field, the band gap of GeS monolayer greatly reduces and a semiconductor–metal transition happens, and their results reveal that the band gaps of GeS monolayer are rather sensitive to the external electric field. For GeS under external strain, quite interestingly, they found that the band gap presents an approximately linear increase not only under compression strain but also under tensile strain from −10% to 10%. The present results provide a simple and effective route to tune the electronic properties of GeS monolayer over a wide range and also facilitate the design of GeS-based two-dimensional devices.

Yunge Zhang
Tsinghua University

Lian Duan
Tsinghua University

FOCUS ON ORGANIC LEDS

Towards highly efficient red thermally activated delayed fluorescence materials by the control of intra-molecular π–π stacking interactions

Yunge Zhang, Dongdong Zhang, Minghan Cai, Yilang Li, Deqiang Zhang, Yong Qiu and Lian Duan
2016 *Nanotechnology* **27** 094001

Abstract
Thermally activated delayed fluorescence (TADF) emitters with red emission are hard to achieve according to the energy gap law. Here, three donor-acceptor-donor type TADF emitters with the same acceptor of o-phthalodinitrile (PN) but different donors (9, 9-dimethyl-9, 10-dihydroacridine (DMAC), phenoxazine (PXZ), and phenothiazine (PTZ) for DMAC-PN, PXZ-PN, and PTZ-PN, respectively) have been synthesized, and it is observed that the performance of the emitters can be improved by reducing the intra-molecular π–π stacking. DMAC-PN with reduced intra-molecular π–π stacking shows a photoluminescence quantum yield of 20.2% in degassed toluene solution, much higher than those of PXZ-PN, and PTZ-PN. An organic light-emitting diode (OLED) employing DMAC-PN doped into 4,4'-bis(9H-carbazol-9-yl)biphenyl (CBP) as the emitting layer exhibits a maximum external quantum efficiency (EQE) of 10.2% peaked at 564 nm. Moreover, when DMAC-PN is doped into a polar host, bis[2-(diphenylphosphino)phenyl] ether oxide (DPEPO), the OLED shows a redshifted emission maximum of 594 nm, while maintaining a peak EQE as high as 7.2%.

Perspectives

Perspective articles are commissioned commentaries authored by researchers in the nanotechnology community, aimed at highlighting the significance, impact and wider implications of research appearing in *Nanotechnology*.

Wenzhuo Wu
Purdue University

High-performance piezoelectric nanogenerators for self-powered nanosystems: quantitative standards and figures of merit

Wenzhuo Wu
2016 *Nanotechnology* **27** 112503

Abstract

Harvesting energies from the atmosphere cost-effectively is critical for both addressing world-wide long-term energy needs at the macro-scale, and achieving the sustainable maintenance-free operation of nanodevices at the micro-scale (Wang and Wu 2012 *Angew. Chem. Int. Ed.* **51** 11700–21). Piezoelectric nanogenerator (NG) technology has demonstrated its great application potential in harvesting the ubiquitous and abundant mechanical energy. Despite of the progress made in this rapidly-advancing field, a fundamental understanding and common standard for consistently quantifying and evaluating the performance of the various types of piezoelectric NGs is still lacking. In their recent study Crossley and Kar-Narayan (2015 *Nanotechnology* **26** 344001), systematically investigated dynamical properties of piezoelectric NGs by taking into account the effect of driving mechanism and load frequency on NG performance. They further defined the NGs' figures of merit as energy harvested normalized by applied strain or stress for NGs under strain-driven or stress-driven conditions, which are commonly seen in the vibrational energy harvesting. This work provides new insight and a feasible approach for consistently evaluating piezoelectric nanomaterials and NG devices, which is important for designing and optimizing nanoscale piezoelectric energy harvesters, as well as promoting their applications in emerging areas e.g. the internet of things, wearable devices, and self-powered nanosystems.

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Review for *Nanotechnology*

Nanotechnology also offers a number of benefits to its reviewers. High-quality reviews are vital to the journal's success, and we have recently increased our efforts to reward regular and accomplished referees.

- Entry into the Reviewer of the Year Award for referees with a history of high-quality, swiftly completed reports.
- Referees who review articles for *Nanotechnology* gain a 10% credit that can be used towards the cost of publishing an article in gold open access. A referee reward credit will be given for every review completed.
- As of early 2017, IOP Publishing is partnering with **Publons**, a free service that enables reviewers to track, verify and showcase their peer-review contributions. Reviewers will get the option to have a verified record of each review added to their Publons profile. By default, only the name of the journal and the year of the review will be displayed, so anonymity of the reviewers is completely protected.

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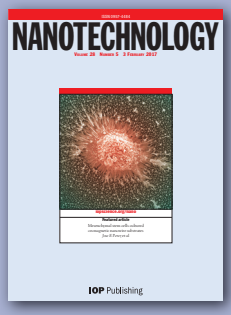

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