

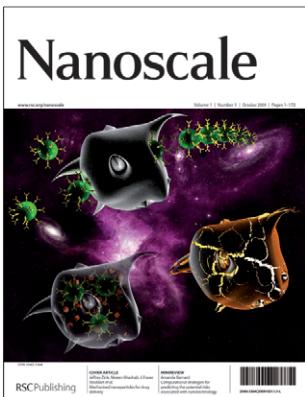
Nanoscale

www.rsc.org/nanoscale

RSC Publishing is a not-for-profit publisher and a division of the Royal Society of Chemistry. Any surplus made is used to support charitable activities aimed at advancing the chemical sciences. Full details are available from www.rsc.org

IN THIS ISSUE

ISSN 2040-3364 CODEN NANOHL 1(1) 1–172 (2009)



Cover

See K. K. Coti *et al.*, pp. 16–39.
Cancer cells, prepare to be boarded and be destroyed!
Image reproduced by permission of J. Fraser Stoddart from *Nanoscale*, 2009, **1**, 16.



Inside cover

See B. Städler *et al.*, pp. 68–73.
An artistic fusion of a biological cell and a synthetic mimic of a cell and its subcellular organelles derived from polymer hydrogel capsules and liposomes assembled via the layer-by-layer technique.
Image reproduced by permission of Frank Caruso from *Nanoscale*, 2009, **1**, 68.

HIGHLIGHTS IN CHEMICAL TECHNOLOGY

T73

Highlights in Chemical Technology provides a ‘snapshot’ of the latest applications and technological aspects of research across the chemical sciences from all RSC publications, showcasing newsworthy articles and significant scientific advances.

**Highlights in
Chemical Technology**

October 2009/Volume 6/Issue 10

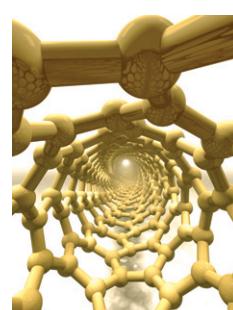
www.rsc.org/highlightschemtechnol

EDITORIAL

13

Nanoscale—a new journal

The best science of the small world in a great new journal!



EDITORIAL STAFF

Managing editor

Philip Earis

Deputy managing editor

Nicola Nugent

Administrative assistant

Fangjie Chen

Assistant manager &

Team leader, Informatics

Michelle Canning

Technical editors

Hilary Burch, Carole Martin

Production administration coordinator

Sonya Spring

Production administration assistants

Aliya Anwar, Jane Orchard, Julie Thompson

Publisher

Janet Dean

Nanoscale (print: ISSN 2040-3364 electronic: ISSN 2040-3372) is published 12 times a year by the Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, UK CB4 0WF.

All orders, with cheques made payable to the Royal Society of Chemistry, should be sent to RSC Distribution Services, c/o Portland Customer Services, Commerce Way, Colchester, Essex, UK CO2 8HP. Tel +44 (0) 1206 226050; E-mail sales@rscdistribution.org

2010 Annual (print + electronic) subscription price: £995; US\$1,800. 2010 Annual (electronic) subscription price: £895; US\$1,620. Customers in Canada will be subject to a surcharge to cover GST. Customers in the EU subscribing to the electronic version only will be charged VAT.

If you take an institutional subscription to any RSC journal you are entitled to free, site-wide web access to that journal. You can arrange access via Internet Protocol (IP) address at www.rsc.org/ip. Customers should make payments by cheque in sterling payable on a UK clearing bank or in US dollars payable on a US clearing bank. Periodicals postage paid at Rahway, NJ, USA, and at additional mailing offices. Airfreight and mailing in the USA by Mercury Airfreight International Ltd., 365 Blair Road, Avenel, NJ 07001, USA.

US Postmaster: send address changes to Nanoscale, c/o Mercury Airfreight International Ltd., 365 Blair Road, Avenel, NJ 07001. All despatches outside the UK by Consolidated Airfreight.

PRINTED IN THE UK.

Advertisement sales:

Tel +44 (0) 1223 432246;
Fax +44 (0) 1223 426017;
E-mail advertising@rsc.org

For marketing opportunities relating to this journal, contact marketing@rsc.org

Nanoscale

www.rsc.org/nanoscale

Nanoscale publishes experimental and theoretical work across the breadth of nanoscience and nanotechnology.



Published in collaboration with the National Centre for Nanoscience and Technology, Beijing, China

EDITORIAL BOARD

Editor-in-Chief, Asia-Pacific

Professor Chunli Bai, National Centre for Nanoscience and Nanotechnology, China

Editor-in-Chief, Europe

Professor Markus Niederberger, ETH Zürich, Switzerland

Editor-in-Chief, North America

Professor Francesco Stellacci, Massachusetts Institute of Technology, USA

Members

Lennart Bergström, Stockholm University, Sweden

Claus Feldmann, University of Karlsruhe, Germany

Sharon Glotzer, The University of Michigan, USA

Xingyu Jiang, National Center for Nanoscience and Technology, China

Molly Stevens, Imperial College London, UK

Dmitri Talapin, University of Chicago, USA

G. Julius Vancso, University of Twente, Netherlands

ADVISORY BOARD

Dario Anselmetti, Bielefeld University, Germany

Yoshinobu Baba, Nagoya University, Japan

Taegewan Hyeon, Seoul National University, Korea

Hiroaki Imai, Keio University, Japan

Song Jin, University of Wisconsin, USA

Graham Leggett, The University of Sheffield, UK

Changming Li, Nanyang Technological University, Singapore

Yunqi Liu, Chinese Academy of Sciences, China

GQ Max Lu, The University of Queensland, Australia

Catherine Murphy, University of South Carolina, USA

Jan van Ruitenbeek, Leiden University, Netherlands

Paolo Samori, University of Strasbourg, France

Abraham Stroock, Cornell University, USA

Daniel Vanmaekelbergh, Utrecht University, Netherlands

Zhong Lin Wang, Georgia Institute of Technology, USA

Dayang Wang, Max Planck Institute of Colloids and Interfaces, Germany

Shu Yang, University of Pennsylvania, USA

Yuliang Zhao, National Center for Nanoscience and Technology, China

INFORMATION FOR AUTHORS

Full details of how to submit material for publication in Nanoscale are given in the Instructions for Authors (available from <http://www.rsc.org/authors>). Submissions should be sent via: <http://www.rsc.org/nanoscale>

Authors may reproduce/republish portions of their published contribution without seeking permission from the RSC, provided that any such republication is accompanied by an acknowledgement in the form: (Original citation) – Reproduced by permission of the Royal Society of Chemistry.

© The Royal Society of Chemistry 2009. Apart from fair dealing for the purposes of research or private study for non-commercial purposes, or criticism or review, as permitted under the Copyright, Designs and Patents Act 1988 and the Copyright and Related Rights Regulations 2003, this publication may only

be reproduced, stored or transmitted, in any form or by any means, with the prior permission in writing of the Publishers or in the case of reprographic reproduction in accordance with the terms of licences issued by the Copyright Licensing Agency in the UK. US copyright law is applicable to users in the USA.

The Royal Society of Chemistry takes reasonable care in the preparation of this publication but does not accept liability for the consequences of any errors or omissions.

© The paper used in this publication meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).

Royal Society of Chemistry:
Registered Charity No. 207890.

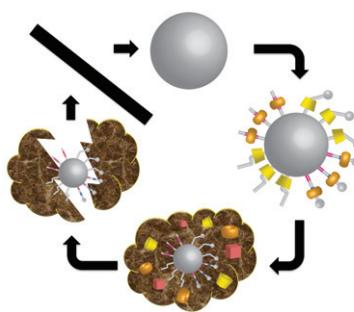
REVIEWS

16

Mechanised nanoparticles for drug delivery

Karla K. Cotí, Matthew E. Belowich, Monty Liong,
 Michael W. Ambrogio, Yuen A. Lau, Hussam A. Khatib,
 Jeffrey I. Zink,* Niveen M. Khashab*
 and J. Fraser Stoddart*

The development of mesoporous silica nanoparticles and the surface-functionalisation of these materials with (super)molecules are reviewed as the need to devise new therapies for the treatment of cancer becomes crucial.

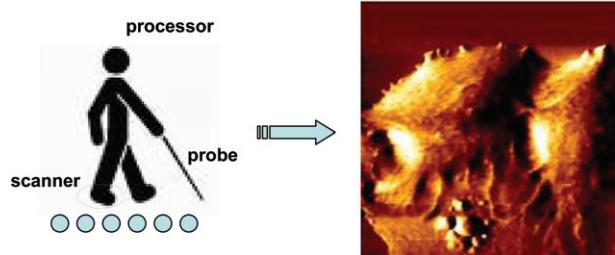


40

The new future of scanning probe microscopy: Combining atomic force microscopy with other surface-sensitive techniques, optical microscopy and fluorescence techniques

Susana Moreno Flores* and José L. Toca-Herrera*

This review shows that the combination of classical scanning probe microscopy with other experimental techniques is a promising research field for the years to come.



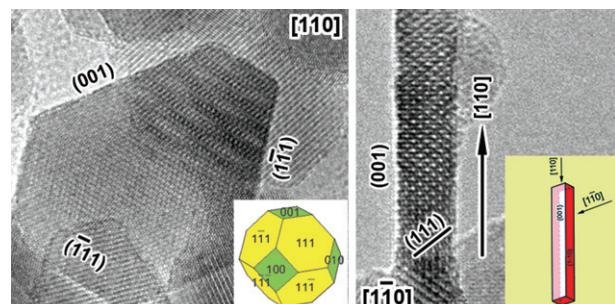
FEATURE ARTICLES

50

Morphology control of cobalt oxide nanocrystals for promoting their catalytic performance

Xiaowei Xie and Wenjie Shen*

We highlight recent advances in morphology-controlled synthesis of nanomaterials and the subsequent development of nanocatalysis using the accumulated knowledge, taking Co_3O_4 nanomaterials as an interesting example.

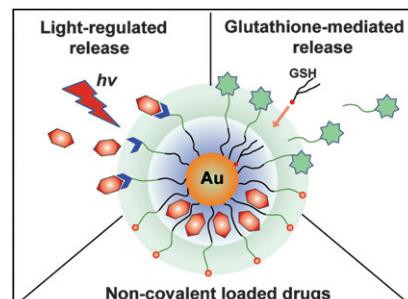


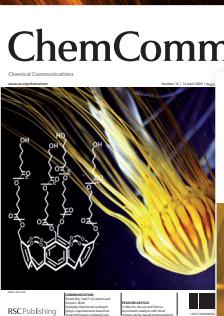
61

Multimodal drug delivery using gold nanoparticles

Chae-kyu Kim, Partha Ghosh and Vincent M. Rotello*

Gold nanoparticles provide effective platforms for drug delivery *via* multiple strategies.





Impact Factor
5.340

Chemical Science



Launching **mid 2010**

Chem Soc Rev



Impact Factor
17.419

A new journal for findings of **exceptional significance** across the chemical sciences

Dynamic

Editor-in-Chief Professor David MacMillan of Princeton, USA will lead a dynamic international team of Associate Editors who will drive the scientific development and make decisions on the content

Unique

A dedicated home for findings of exceptional significance from across ALL the chemical sciences. In a break with tradition, the journal will give authors the freedom and flexibility to publish more extensive accounts of their novel research without page restrictions

A leader

At the forefront of the most exciting developments in the chemical sciences, helping to define the important areas by publishing the most significant cutting-edge research

High impact

Building on the successes of related RSC flagship journals Chemical Communications and Chemical Society Reviews, both of which enjoy an international reputation for high quality content and speed of publication

Discover... Read... Follow... Register today

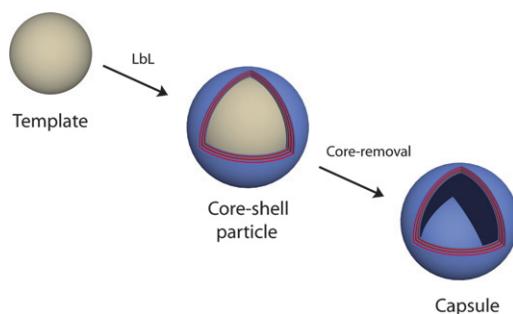
MINIREVIEWS

68

Polymer hydrogel capsules: en route toward synthetic cellular systems

Brigitte Städler, Andrew D. Price, Rona Chandrawati, Leticia Hosta-Rigau, Alexander N. Zelikin and Frank Caruso*

We outline recent progress in the bottom-up assembly of functional LbL-assembled carrier vehicles for the development of therapeutic artificial cells and organelles.

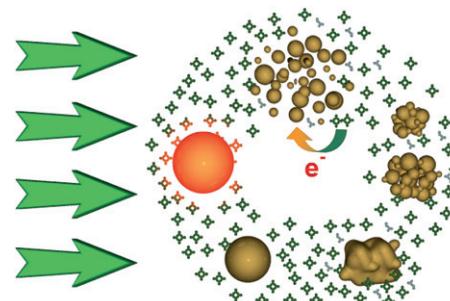


74

Self-healing at the nanoscale

Vincenzo Amendola* and Moreno Meneghetti*

Self-healing is a fundamental process for natural systems and will be very important also for nanostructures which can preserve their structures and functional properties.

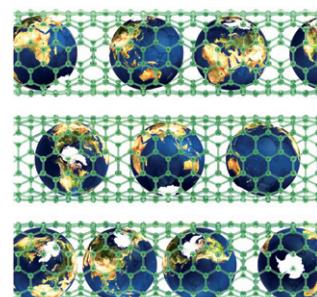


89

Computational strategies for predicting the potential risks associated with nanotechnology

Amanda S. Barnard*

Much of the recent discussion of potential hazards and risks associated with nanotechnology has focussed on inherently experimental approaches to the problem. This article highlights a number of areas in which theory and computation can help develop our understanding of instabilities relevant to 'nano-hazards', and shows how a strategic partnership between computational and experimental studies is essential for forming the predictions required for prevention.

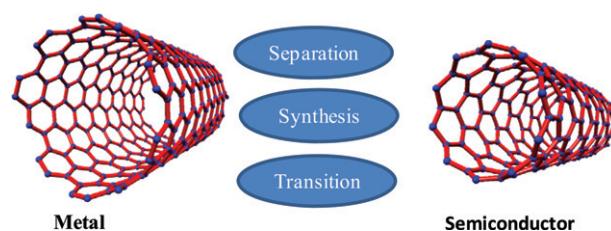


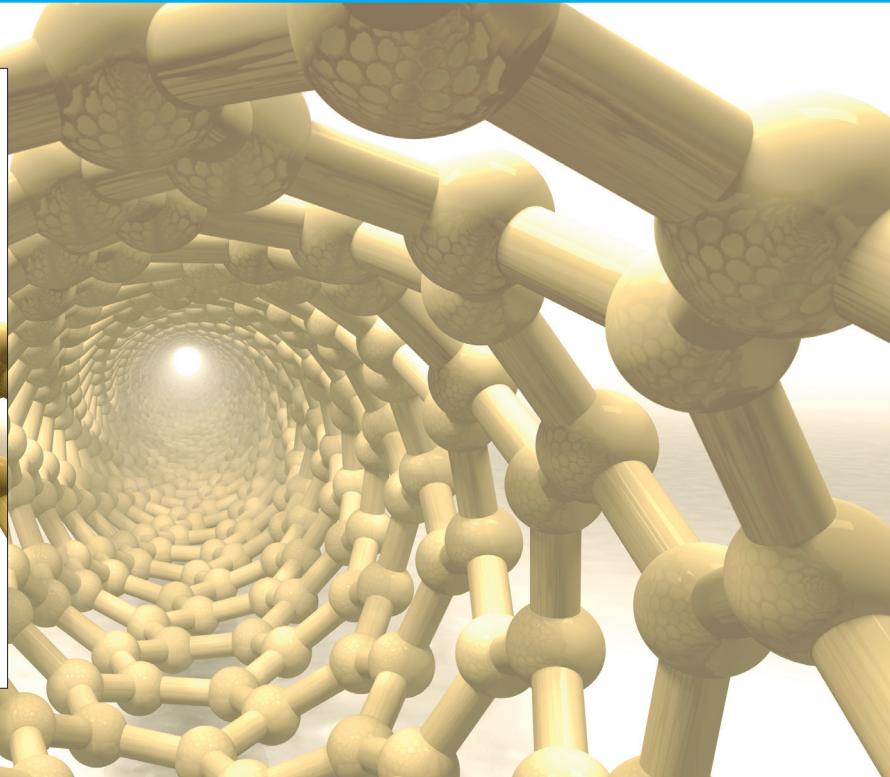
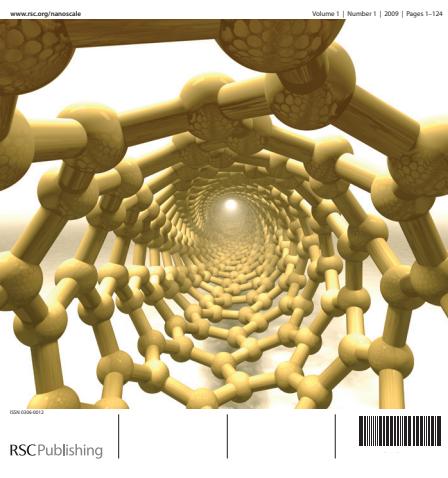
96

Selective generation of single-walled carbon nanotubes with metallic, semiconducting and other unique electronic properties

C. N. R. Rao,* Rakesh Voggu and A. Govindaraj

As-prepared carbon nanotubes are mixtures of metallic and semiconducting species, but it is possible to separate them by chemical means and to selectively prepare either species.





Coming soon

What amount of metallic impurities in carbon nanotubes is small enough not to dominate their redox properties?

Martin Pumera and Yuji Miyahara, *Nanoscale*, 2009

DOI: 10.1039/b9nr00071b

Interactions between metals and carbon nanotubes: at the interface between old and new materials

Florian Banhart, *Nanoscale*, 2009

DOI: 10.1039/b9nr00127a

Does mesoporosity enhance thin film properties? A question of electrode material for electrochromism of WO₃

Rainer Ostermann and Bernd Smarsly, *Nanoscale*, 2009

DOI: 10.1039/b9nr00091g

The synthesis of rare earth fluoride based nanoparticles

Paula Rahman and Mark Green, *Nanoscale*, 2009

DOI: 10.1039/b9nr00089e

An organic matrix-mediated processing methodology to fabricate hydroxyapatite based nanostructured biocomposites

Prakash Hariram Kithva, Lisbeth Grøndahl, Rajendra Kumar, Darren Martin and Matt Trau, *Nanoscale*, 2009

DOI: 10.1039/b9nr00062c

Dendritic structures within dendritic structures: dendrimer-induced formation and self-assembly of nanoparticle networks

Grégoire Franc, Elena Badetti, Vincent Collière, Jean-Pierre Majoral, Rosa María Sebastián and Anne-Marie Caminade, *Nanoscale*, 2009

DOI: 10.1039/b9nr00056a

The current issue is freely available online
Register for free institutional online access to all 2009 and 2010 content at www.rsc.org/free_access_registration

COMMUNICATIONS

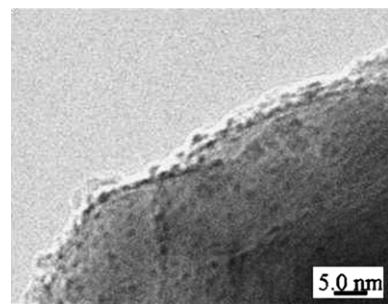
106



Highly dispersed noble-metal/chromia (core/shell) nanoparticles as efficient hydrogen evolution promoters for photocatalytic overall water splitting under visible light

Naoyuki Sakamoto, Hajime Ohtsuka, Takahiro Ikeda, Kazuhiko Maeda, Daling Lu, Masayuki Kanehara, Kentaro Teramura, Toshiharu Teranishi and Kazunari Domen*

Noble-metal nanoparticles (NPs) were loaded on photocatalysts without aggregation, achieving improved visible-light water splitting when the NPs are coated with a chromia shell.



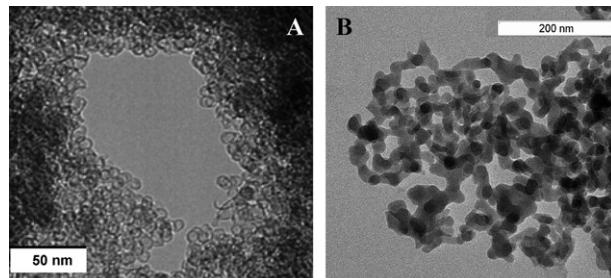
110



Synthesis of $\text{Li}_y\text{MnSiO}_x$ and LiMnPO_4 nanostructures

Bettina Milke, Peter Strauch, Markus Antonietti and Cristina Giordano*

We report a simple and relatively fast hydrothermal route to prepare both $\text{Li}_y\text{MnSiO}_x$ and LiMnPO_4 with different sizes and shapes simply by changing the reaction parameters, and illustrate the textural complexity of the system.



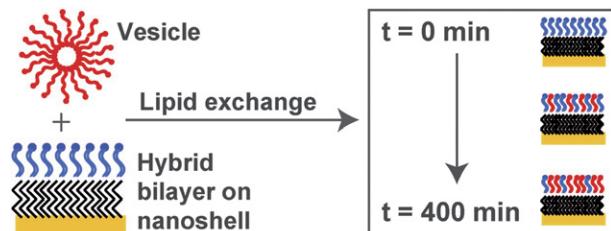
114



Real-time monitoring of lipid transfer between vesicles and hybrid bilayers on Au nanoshells using surface enhanced Raman scattering (SERS)

Janardan Kundu, Carly S. Levin and Naomi J. Halas*

The exchange/transfer of lipids between vesicles and supported bilayers on Au nanoshells of comparable sizes, monitored in real time, shows evidence of partial lipid exchange/transfer following first order kinetics.



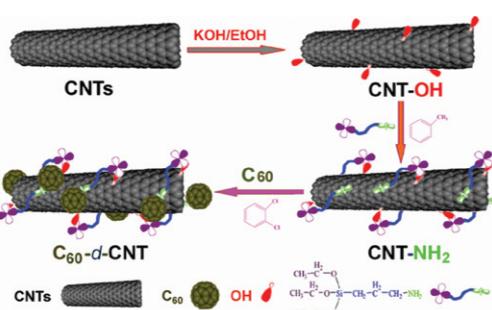
118



Fabrication of fullerene-decorated carbon nanotubes and their application in flame-retarding polypropylene

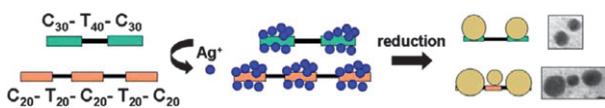
Pingan Song, Yu Shen, Baoxian Du, Zhenghong Guo and Zhengping Fang*

Multi-walled carbon nanotubes were decorated with C_{60} via a three-step chemical functionalization, with the goal of combining their unique characteristics and simultaneously improving the solubility of the nanotubes.



PAPERS

122

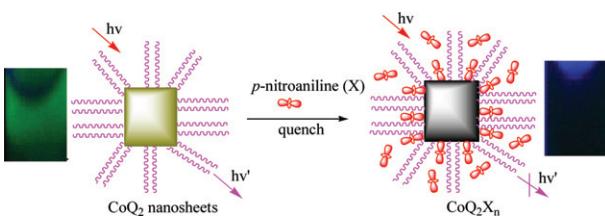


Probing differential Ag^+ -nucleobase interactions with isothermal titration calorimetry (ITC): Towards patterned DNA metallization

Sourabh Shukla and Murali Sastry*

Differences in Ag^+ -nucleobase binding affinities are exploited to achieve sequence-specific DNA metallization.

128

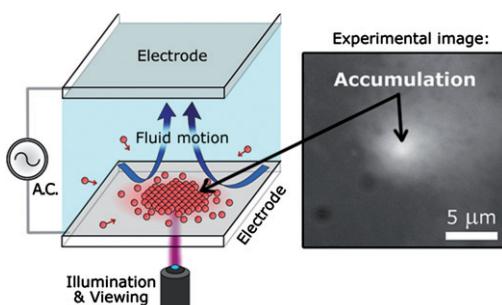


Synthesis of highly luminescent cobalt(II)-bis(8-hydroxyquinoline) nanosheets as isomeric aromatic amine probes

Haibing Li* and Yuling Li

Water-soluble, stable and highly fluorescent cobalt(II)-bis(8-hydroxyquinoline) (CoQ_2) nanosheets have been synthesized as a fluorescent probe for the determination of *p*-nitroaniline *via* fluorescence quenching and color change.

133

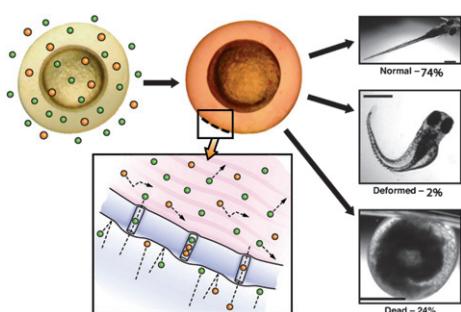


A simple, optically induced electrokinetic method to concentrate and pattern nanoparticles

Stuart J. Williams, Aloke Kumar, Nicolas G. Green and Steven T. Wereley*

We have introduced a novel optically-induced method that couples electrothermal microfluidic motion with low-frequency electrokinetics for nanoparticle concentration and patterning.

138



Random walk of single gold nanoparticles in zebrafish embryos leading to stochastic toxic effects on embryonic developments

Lauren M. Browning, Kerry J. Lee, Tao Huang, Prakash D. Nallathamby, Jill E. Lowman and Xiao-Hong Nancy Xu*

We have synthesized and characterized stable Au nanoparticles, and used them to probe nanoparticle transport and diffusion in cleavage-stage zebrafish embryos, and to study their effects on embryonic development in real-time.

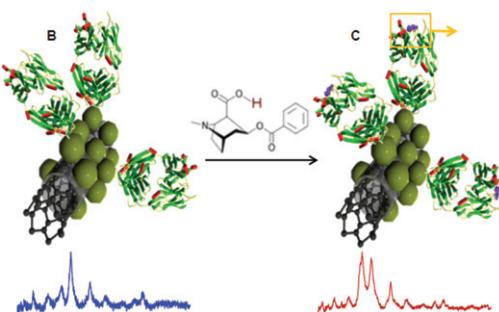
PAPERS

153

Label-free SERS detection of relevant bioanalytes on silver-coated carbon nanotubes: The case of cocaine

Marcos Sanles-Sobrido, Laura Rodríguez-Lorenzo,
Silvia Lorenzo-Abalde, África González-Fernández,
Miguel A. Correa-Duarte,* Ramón A. Alvarez-Puebla*
and Luis M. Liz-Marzán

SERS quantification of relevant small biometabolites by using the combination of a platform with a high density of hot spots (CNT@Ag) and monoclonal antibodies.

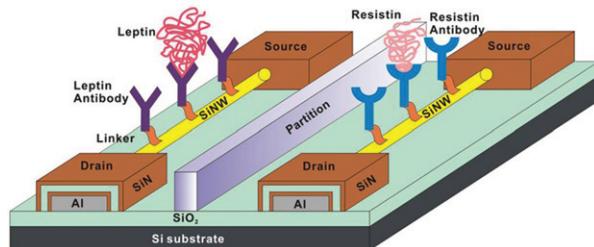


159

Ultra-sensitive detection of adipocytokines with CMOS-compatible silicon nanowire arrays

Tze-Sian Pui, Ajay Agarwal, Feng Ye, Zhi-Qiang Tou,
Yinxi Huang and Peng Chen*

Silicon nanowires fabricated by a top-down CMOS-compatible method can detect adipocytokines secreted by fat cells with femtomolar sensitivity, high specificity, wide detection range, and ability for parallel sensing.

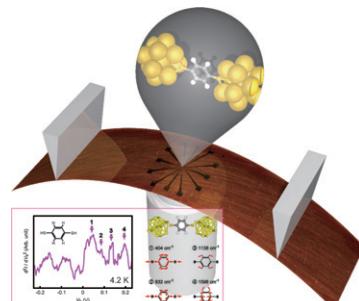


164

Identifying molecular signatures in metal-molecule-metal junctions

Makusu Tsutsui, Masateru Taniguchi,^{*} Kohei Shoji,
Kazumichi Yokota and Tomoiji Kawai^{*}

We demonstrate single molecule identification in metal-molecule-metal junctions by revealing a clear correspondence of the molecular vibrational spectra to the Raman spectroscopy counterparts.



AUTHOR INDEX

- Agarwal, Ajay, 159
 Alvarez-Puebla, Ramón A., 153
 Ambrogio, Michael W., 16
 Amendola, Vincenzo, 74
 Antonietti, Markus, 110
 Barnard, Amanda S., 89
 Belowich, Matthew E., 16
 Browning, Lauren M., 138
 Caruso, Frank, 68
 Chandrawati, Rona, 68
 Chen, Peng, 159
 Correa-Duarte, Miguel A., 153
 Cotí, Karla K., 16
 Domen, Kazunari, 106
 Du, Baoxian, 118
 Fang, Zhengping, 118
 Ghosh, Partha, 61
 Giordano, Cristina, 110
 González-Fernández, África, 153
 Govindaraj, A., 96
 Green, Nicolas G., 133
 Guo, Zhenghong, 118
 Halas, Naomi J., 114
 Hosta-Rigau, Leticia, 68
 Huang, Tao, 138
 Huang, Yinxin, 159
 Ikeda, Takahiro, 106
 Kanehara, Masayuki, 106
 Kawai, Tomoji, 164
 Khashab, Niveen M., 16
 Khatib, Hussam A., 16
 Kim, Chae-kyu, 61
 Kumar, Aloke, 133
 Kundu, Janardan, 114
 Lau, Yuen A., 16
 Lee, Kerry J., 138
 Levin, Carly S., 114
 Li, Haibing, 128
 Li, Yuling, 128
 Liong, Monty, 16
 Liz-Marzán, Luis M., 153
 Lorenzo-Abalde, Silvia, 153
 Lowman, Jill E., 138
 Lu, Daling, 106
 Maeda, Kazuhiko, 106
 Meneghetti, Moreno, 74
 Milke, Bettina, 110
 Moreno Flores, Susana, 40
 Nallathamby, Prakash D., 138
 Ohtsuka, Hajime, 106
 Price, Andrew D., 68
 Pui, Tze-Sian, 159
 Rao, C. N. R., 96
 Rodríguez-Lorenzo, Laura, 153
 Rotello, Vincent M., 61
 Sakamoto, Naoyuki, 106
 Sanles-Sobrido, Marcos, 153
 Sastry, Murali, 122
 Shen, Wenjie, 50
 Shen, Yu, 118
 Shoji, Kohei, 164
 Shukla, Sourabh, 122
 Song, Pingan, 118
 Städler, Brigitte, 68
 Stoddart, J. Fraser, 16
 Strauch, Peter, 110
 Taniguchi, Masateru, 164
 Teramura, Kentaro, 106
 Teranishi, Toshiharu, 106
 Toca-Herrera, José L., 40
 Tou, Zhi-Qiang, 159
 Tsutsui, Makusu, 164
 Voggu, Rakesh, 96
 Wereley, Steven T., 133
 Williams, Stuart J., 133
 Xie, Xiaowei, 50
 Xu, Xiao-Hong Nancy, 138
 Ye, Feng, 159
 Yokota, Kazumichi, 164
 Zelikin, Alexander N., 68
 Zink, Jeffrey I., 16

FREE E-MAIL ALERTS AND RSS FEEDS

Contents lists in advance of publication are available on the web via www.rsc.org/nanoscale – or take advantage of our free e-mail alerting service (www.rsc.org/ej_alert) to receive notification each time a new list becomes available.

 Try our RSS feeds for up-to-the-minute news of the latest research. By setting up RSS feeds, preferably using feed reader software, you can be alerted to the latest Advance Articles published on the RSC web site. Visit www.rsc.org/publishing/technology/rss.asp for details.

ADVANCE ARTICLES AND ELECTRONIC JOURNAL

Free site-wide access to Advance Articles and the electronic form of this journal is provided with a full-rate institutional subscription. See www.rsc.org/ejs for more information.

* Indicates the author for correspondence: see article for details.

 Electronic supplementary information (ESI) is available via the online article (see <http://www.rsc.org/esi> for general information about ESI).



Celebrating 5 years of publication

Number one in the field

Soft Matter launched in 2005 with the aim of bringing together research communities across physics, chemistry, biology, materials science, and engineering - offering a platform where scientists can turn for interdisciplinary inspiration.

With the top impact factor (4.59) and immediacy index (0.83) of any journal in the field,* *Soft Matter* is the place to find exciting and innovative research that crosses all borders. With a truly international readership and authorship, the journal attracts submissions from across the globe and – in a clear reflection of its success – moved from 12 to 24 issues a year in 2009.

Submit your work now

* 2008 Thomson Scientific (ISI) Journal Citation Reports®

RSC Publishing

www.softmatter.org
Registered Charity Number 207890

Highlights in

Chemical Technology

Dye extraction product recycled as cheap colourant for plastics

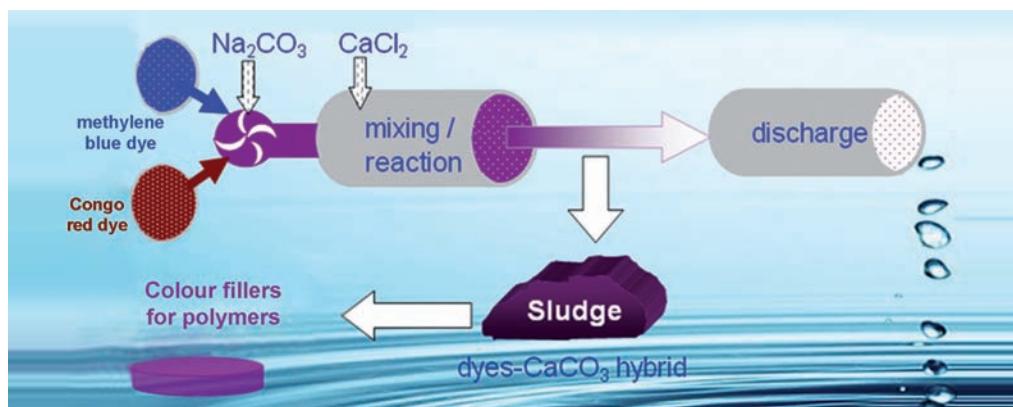
A colourful way to clean waste

Chinese scientists have developed a cheap, eco-friendly method to extract dyes from wastewater. The waste dyes can then be used to colour plastics, they say.

Azo dyes are commonly used to colour fabrics in the textile industry. But many of them can cause cancer and so pose a health hazard when released into the environment in wastewater.

Hong-Wen Gao and colleagues from Tongji University, Shanghai, mixed two wastewater samples – one containing a cationic azo dye and the other an anionic one. They added sodium carbonate followed by calcium chloride and the dyes precipitated out of solution as a dye–calcium carbonate hybrid. Spectrophotometry measurements revealed that the process removed over 98 per cent of the dyes.

Currently, dyes are removed from industrial wastewater by either adsorption, for example onto activated carbon, or chemical



processes, such as electrolysis. But these methods produce a lot of waste and are expensive.

'One of the most impressive aspects of this work seems to be the high adsorption capacity,' says Ryan Richards, a dye extraction expert at the Colorado School of Mines, Golden, US – the hybrid absorbs about seven times more dye than conventional adsorbents.

The hybrid can also be used for

The dye-calcium carbonate hybrid precipitates as a sludge that can be reused to colour plastics

Reference

D-H Zhao, Y-L Zhang, Y-P Wei and H-W Gao, *J. Mater. Chem.*, 2009, DOI:10.1039/b911830f

colouring plastics, rubber and paint. This removes the need for waste disposal and replaces the metal oxides commonly used as colourants.

Gao sees no obstacles to industrial implementation: 'The adsorbent can be prepared simply with available inorganic raw materials and used directly in wastewater treatment.'

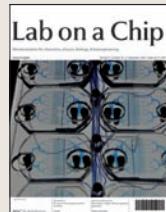
Christina Hodgkinson

In this issue

[Find us on...](#)

Sound waves push particles

Acoustic tweezers manipulate cells into patterns on a microchip



Analyte sensing made easy

Drug abuse detected by antibody-coated nanoparticles



Microfluidics makes its mark

Point-of-care diagnostics driven by capillary force

Instant insight: Zooming in on sensors

Seunghun Hong and colleagues discuss ways to integrate nanowires and nanotubes on chips

The latest applications and technological aspects of research across the chemical sciences

Application highlights

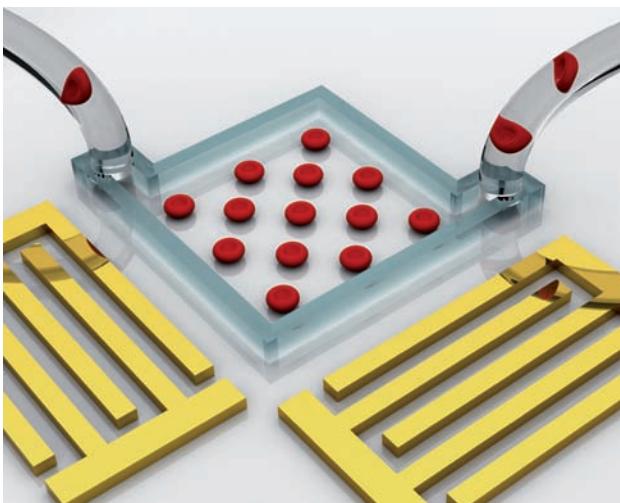
Acoustic tweezers manipulate cells without damaging them

Sound waves push particles

US scientists have used sound waves to manipulate particles into desired patterns on a microchip. They claim the technique, called acoustic tweezers, is particularly suitable for positioning samples for tissue engineering because it doesn't damage cells.

Tony Jun Huang and colleagues at the Pennsylvania State University, University Park, made the tweezers by placing two energy conversion devices called interdigital transducers (IDTs) on the outside of a microfluidic channel. They added a microparticle solution to the channel and then applied a radio frequency signal to the IDTs. The IDTs converted the signal into sound waves called surface acoustic waves (SAWs), which pushed the microparticles into precise patterns in the channel.

SAWs are very energy efficient, Huang explains – acoustic tweezers use 500 000 times less power



than optical tweezers, an existing patterning method. This makes them cheaper and also prevents damage to biological samples.

The tweezers work on a variety of different cells and particles

The interdigital transducers (yellow) emit surface acoustic waves that push particles into position

regardless of size, shape or charge, adds Huang. The team used them to pattern polystyrene beads, *Escherichia coli* and red blood cells.

'This is a very interesting way of using acoustic waves, as SAWs have not been used for this sort of application before,' states Michael Thompson, an acoustic wave expert at the University of Toronto, Canada.

Huang says future research will be focused in two directions. 'Firstly, we are going smaller by manipulating nano-objects, such as DNA, viruses and nanowires,' he comments. 'Secondly, we want to use our acoustic tweezers in biomedicine. We have already talked to cell biologists and they are very interested in this technology.'

Jane Hordern

Reference
J Shi *et al*, *Lab Chip*, 2009, DOI: 10.1039/b906595f

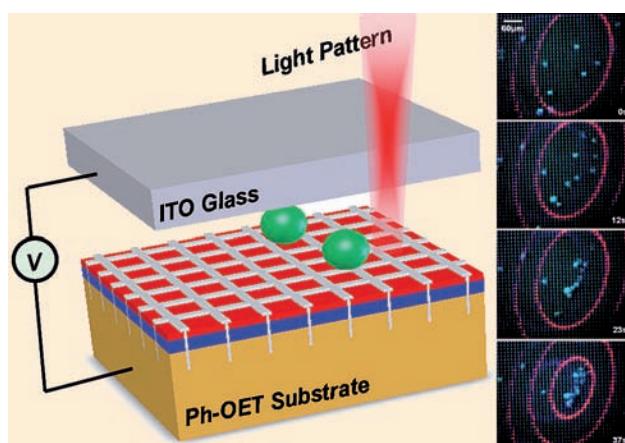
Phototransistor improves conductivity of optoelectronic tweezers

Cell sorting is no fixed matter

Single cells can now be manipulated in physiological buffers without damage or interruption to cell functions thanks to a new device developed by US scientists.

Optoelectronic tweezers (OETs) use silicon photoconductors to capture light and induce an electric field that can move cells by attracting or repelling them. But because amorphous silicon's photoconductivity is low, the OETs only work in media with low conductivities. Cell culture media and physiological buffers have high conductivities so can only be used with OETs if their salts are replaced with non-conducting molecules. However, this causes cells to lose their normal functions.

Now Hsian-yin Hsu, at the University of California, Berkeley, and colleagues have adapted the technology by replacing the silicon



The phototransistor generates an electric field that exerts a force on the particles or cells

photoconductors with crystalline silicon wafer phototransistors doped with boron and arsenic. This enhances photoconductivity by two orders of magnitude, says Hsu. 'With optical illumination, the photosensitive layer has higher conductivity than the media and becomes electrode-like. This

allows it to operate with highly conductive media,' he explains.

'The approach is compelling as it yields a cell-handling platform that could readily be implemented, enabling studies of fundamental properties of cells,' comments Jody Vykoukal, an expert in microfluidics and cell separation at the University of Texas, Houston, US.

Hsu expects that the device will have a broad impact in cell-based biology research. 'Equipped with this new tool, we are pursuing the sorting of differentiated neural cells for cell replacement therapy and developing a smart petri dish in which cells can be tested, sorted and collected while they are being cultured,' he says.

Keith Farrington

Reference
H Y Hsu *et al*, *Lab. Chip*, 2009, DOI: 10.1039/b906593h

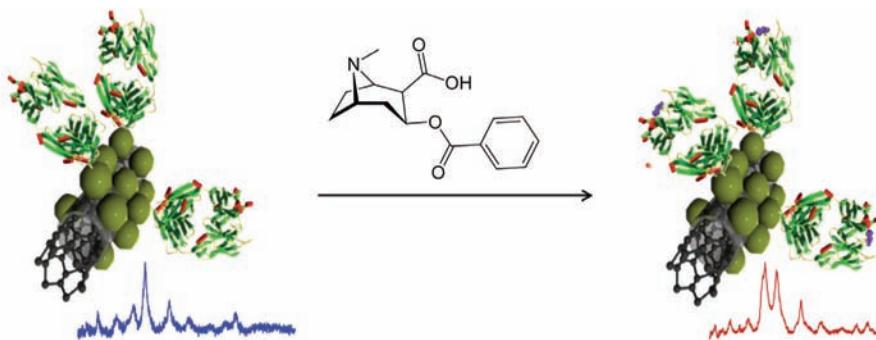
Silver-coated carbon nanotubes support metabolite detection

Analyte sensing made easy

Spanish scientists have made antibody-coated nanoparticles that can detect bioanalytes indicative of drug abuse.

Ramón Alvarez-Puebla and colleagues at the University of Vigo attached antibodies specific to a major cocaine metabolite, benzoylecgonine, to the surface of carbon nanotube-supported silver nanoparticles. They then added a solution of benzoylecgonine, which bound to the antibodies and caused a change in their structure. The team showed that surface-enhanced Raman spectroscopy (SERS) could be used to monitor the structural changes and determine the metabolite concentration.

The method can be performed in biological fluids, such as saliva or urine, says Alvarez-Puebla, and can determine not only the drug's presence but also the amount consumed. It could also be used to detect disease-related biomolecules,



he suggests.

Current SERS analytical techniques usually require preparatory steps, such as the incorporation of labels that give a signal when molecules of interest are present. [This method] is interesting because you do not need to prepare the sample at all,' Alvarez-Puebla comments. The method's sensitivity matches that of established techniques, he adds.

Douglas Stuart, from the University of West Georgia, Carrollton, US,

When the metabolite binds to the antibodies it causes a change in the SERS spectrum

who specialises in SERS and nanotechnology, is impressed by the work. 'It is a very elegant approach that takes an unintended consequence [the structural change of the antibody] and uses it as a detection method – a slick trick!'

The group are now working on developing new sensors, including those capable of monitoring more than one analyte, for use in high-throughput screening.

Matthew Batchelor

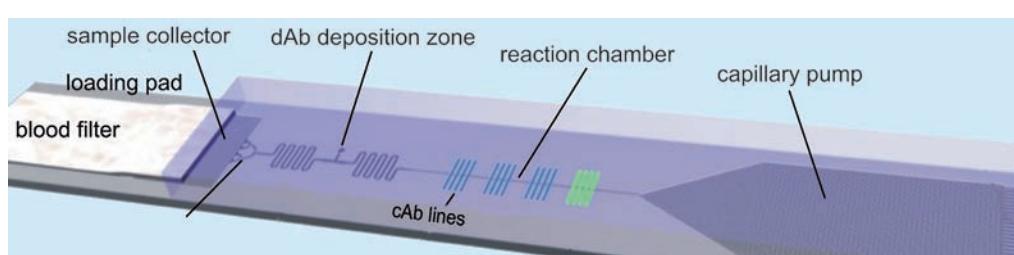
Reference
M Sanles-Sobrido et al,
Nanoscale, 2009, DOI:10.1039/
b9nr00059c

Point-of-care diagnostics driven by capillary force

Microfluidics makes its mark

Scientists in Switzerland have developed a one-step microfluidic chip that can detect disease markers in a single drop of blood serum. The chip could be used for cheap, quick and versatile point-of-care diagnostics, they claim.

The chip, made by Emmanuel Delamarche and Luc Gervais from IBM Research, Rüschlikon, contains capillary valves and pumps plus two types of antibodies – detection antibodies (dAbs), which fluoresce under light excitation, and capture antibodies (cAbs). When the pair introduced a serum sample onto the chip, capillary forces drew it into the microfluidic channel, where the dAbs bound to complementary analytes in the serum. The analyte-dAbs complexes then flowed through the chip into the cAbs-patterned reaction chamber, where they were captured and the fluorescence measured using an external fluorescence reader. This one-step fluorescence immunoassay



could simplify disease diagnosis, claims Gervais.

The duo demonstrated that the chip can detect C-reactive protein, an inflammation and cardiac marker, at a concentration of 10 nanograms per millilitre in less than three minutes.

Most point-of-care devices require large sample sizes and off-chip processing or can only detect a small number of markers. 'This is an autonomous device that only requires the addition of sample to perform analysis,' states Gervais, adding that it needs only five microlitres of sample. The system can draw the sample in

The device only requires sample addition to trigger a cascade of events powered by capillary forces

without introducing air bubbles, a known problem in microfluidics. Gervais also draws attention to the system's versatility: 'You could have 16 different capture antibodies and analyse up to 16 different analytes.'

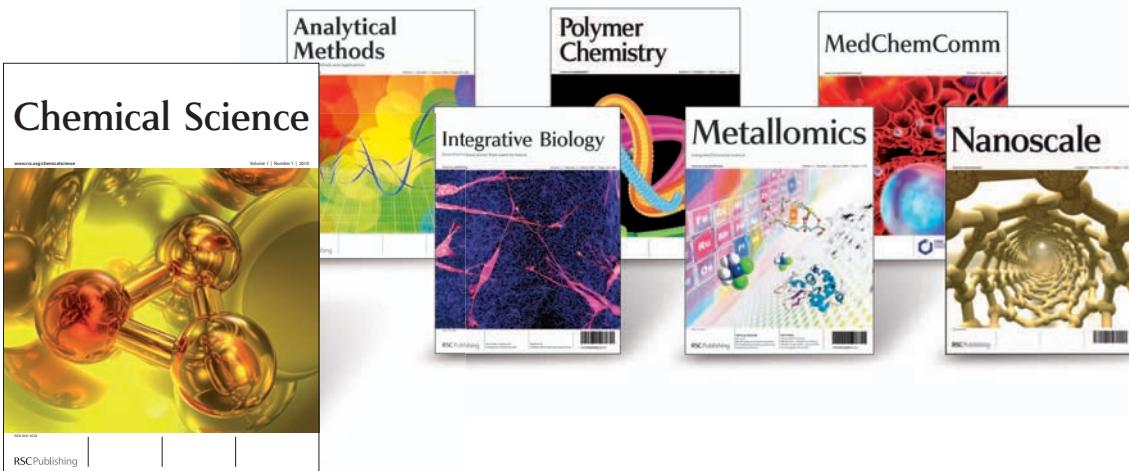
'It is a very powerful system because it's very sensitive and extremely easy to use,' says David Holmes, a microfluidics expert at the University of Southampton, UK.

Gervais says they now plan to try the device with different disease markers and improve its range of detectable concentrations.

Yuandi Li

Reference
L Gervais and E Delamarche,
Lab Chip, 2009, DOI: 10.1039/
b906523g

Top science ...free institutional access



New for 2010

Chemical Science - a new journal presenting findings of exceptional significance from across the chemical sciences. www.rsc.org/chemicalscience

MedChemComm - focusing on medicinal chemistry research, including new studies related to biologically-active chemical or biochemical entities that can act as pharmacological agents with therapeutic potential or relevance. www.rsc.org/medchemcomm

Polymer Chemistry - publishing advances in polymer chemistry covering all aspects of synthetic and biological macromolecules, and related emerging areas. www.rsc.org/polymers

New for 2009

Analytical Methods - highlights new and improved methods for the practical application of analytical science. This monthly journal will communicate research in the advancement of analytical techniques for use by the wider scientific community. www.rsc.org/methods

Integrative Biology - focusing on quantitative multi-scale biology using enabling technologies and tools to exploit the convergence of biology with physics, chemistry, engineering, imaging and informatics. www.rsc.org/ibiology

Metallomics - covering the research fields related to metals in biological, environmental and clinical systems. www.rsc.org/metallomics

Nanoscale - publishing experimental and theoretical work across the breadth of nanoscience and nanotechnology. www.rsc.org/nanoscale

Free institutional access, managed by IP address, is available on all these titles. For more details, and to register, visit www.rsc.org/free_access_registration

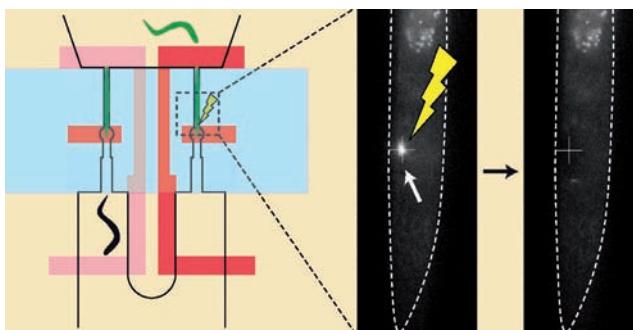
Neurosurgery on a worm reveals clues to development and behaviour

An on-chip operation

US scientists have speeded up worm microsurgery to improve our understanding of animal behaviour.

Hang Lu and Kwanghun Chung from the Georgia Institute of Technology, Atlanta, designed a high throughput microfluidic system that can handle and operate on a worm known as *Caenorhabditis elegans*.

Neuroscientists are keen to understand how cells in the brain contribute to an organism's behaviour. By destroying individual neurons using a laser beam (laser ablation) then monitoring the organism's behaviour, they can infer the function of each neuron. They often use *C. elegans* as a model organism because it is see-through and its anatomy is well known. But *C. elegans* has a short lifespan and the slow ablation methods currently used mean that worms of different



ages are used, which introduces variation into the study.

Lu and Chung's device has two sets of worm-loading channels that operate at the same time. Worms enter and exit at one set, while imaging and laser ablation are performed at the other. A constant pressure directs the worms to the channels, which only fit one

The worm in the right loading channel is ablated while another worm is loaded in the left loading channel

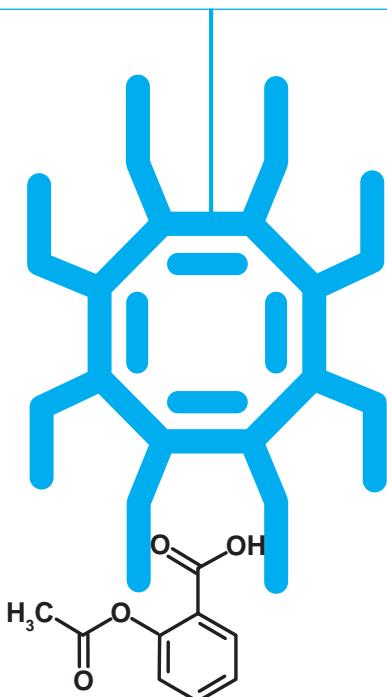
Reference

K Chung and H Lu, *Lab Chip*, 2009, **9**, 2764 (DOI:10.1039/b910703g)

worm at a time. Valves are used to position them and when properly loaded, both ends of the channels are closed. The worms are then immobilised by cooling to enable accurate neuron ablation. After ablation, the worm is released from the channel. The process takes 20 to 30 seconds, much quicker than the 30 minutes it takes to ablate neurons manually.

'Unlike much of the work in this field, the authors collected worms post-surgery and carried out behavioural assays. This makes for a complete and compelling story – very exciting,' says Aaron Wheeler, a microfluidics expert at the University of Toronto, Canada.

Lu says he will use the system for many applications in development and behavioural neuroscience in model organisms. Michael Brown

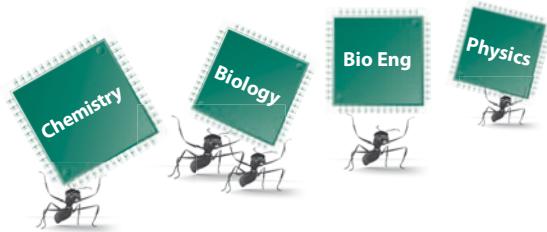


New adventures on the web

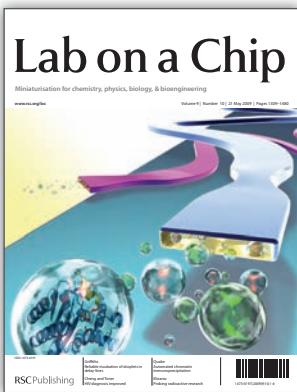
ChemSpider is a free online, structure centric community for chemists, providing fast access to millions of unique chemical entities, resources and information and the opportunity to collaborate with a world wide community of scientists. Rapidly becoming the richest single source of structure based chemistry information online, ChemSpider is a ground breaking initiative now supported by the RSC, the most innovative of chemical societies.

www.chemspider.com

... be part of something bigger!



Lab on a Chip publishes the latest key developments, novel applications and fundamental research at the micro- and nano-scale.



- Impact factor: 6.5* (28% increase from previous year)
- Sponsor of the Pioneers in Miniaturisation Prize
- *Lab on a Chip* YouTube channel
- Host of 'Chips & Tips' the free online forum for sharing best practice and exchange of ideas
- Indexed in MEDLINE
- Fast publication times of typically 100 days

070983

*2008 Thomson Scientific (ISI) Journal Citation Reports

RSC Publishing

www.rsc.org/loc

Registered Charity Number 207890

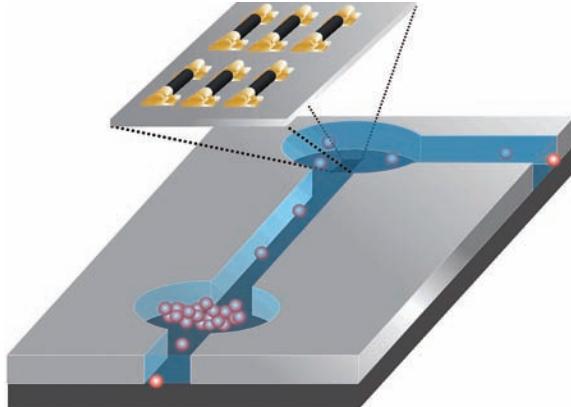
Instant insight

Zooming in on sensors

Nanostructures have the potential to transform the way we investigate life processes but only if we can find good ways to make them. Seunghun Hong, at Seoul National University, Korea, and colleagues discuss ways to integrate nanowires and nanotubes on chips

Recent advances in nanotechnology have enabled high resolution chemical and biological detection – as sensors get smaller, their detection limit improves. So 1D nanostructures make ideal building blocks for sensors. These nanostructures, including nanowires (NWs) and single-walled carbon nanotubes (SWNTs), make it possible to detect individual molecules. For example, scientists have used SWNTs to measure the conductivity change caused by a single base pair mismatch in DNA. Combining these new components on lab-on-a-chip formats brightens the prospect for scientists developing advanced tools to investigate biochemical and life processes.

A major technological bottleneck holding back the practical applications of 1D nanostructure-based sensors has been the lack of ways to mass produce them. But in recent years, many researchers have demonstrated various promising mass fabrication methods. The selective growth strategy, where nanostructures are grown on patterns of catalysts, was one of the earliest growth concepts. While it enables scientists to position high purity structures at desired locations, it is more difficult on larger scales and does not work for some NWs. On the large scale, solution-phase synthesis is more promising as it requires cheaper equipment and lower temperatures. But the nanostructures must be directed to grow on specific locations and researchers have resorted to a variety of directed assembly strategies to achieve this. Electric fields, fluidic flows and magnetism have all been used as external guiding forces to align and



position nanostructures.

Internal interactions can also be used. For example, scientists have functionalised solid substrates with self-assembled monolayers to create surface charge or polarisation that directs the absorption and alignment of NWs.

Although these methods have clearly shown the possibility for practical applications, assembling NWs and SWNTs on soft substrates, such as plastic, requires a different method. In this case, the assembly process must not involve high temperatures or reactive chemical treatments. And so printing technologies have emerged as a powerful tool. For example, by depositing NW solutions on a polymer stamp and blowing away the solvent, scientists made NW-inked stamps that could transfer the NWs on to the desired substrates.

Apart from practical applications, nanotechnology's largest contribution may be in opening up multidisciplinary science. Electronic devices previously unrelated to biotechnology are now being combined with biomolecules to make sensors capable of monitoring very low concentrations of disease-related

Nanowire and nanotube-based transistors could be versatile components of lab-on-a-chip sensors

molecules. It was only when the size of devices became comparable to that of biomolecules that the sensitivity really improved. Now scientists have made numerous biosensors using semiconductor NW or SWNT field effect transistors (FETs). Most NW FETs are made of silicon because its surface chemistry is well known and it is highly conductive, making it possible to create very sensitive sensors. But SWNTs are also attractive for sensors because they are even better at transporting electrons. The first generation of SWNT sensors is already on the market.

Reported nanotube sensors can be divided into two categories: those that contain a small number of semiconducting nanotubes and those that consist of SWNT networks. There is not yet a method to grow nanotubes with uniform chirality and so the yield of the devices in the first category is rather low – one needs chemical or electrical sorting to ensure single semiconducting behaviour. On the other hand, mass production of SWNT network devices is possible, but electrons move less easily through them.

In tandem with experiments, scientists are using modelling to try to understand the fundamental sensing mechanism of these FETs. They hope that by combining theoretical and experimental studies, they will be able to design NW and SWNT FETs that will be ideal candidates for future lab-on-a-chip components.

Read more in "Nanowire and nanotube transistors for lab-on-a-chip applications" in issue 16 of Lab on a Chip.

Reference

M Lee *et al*, *Lab Chip*, 2009, **9**, 2267 (DOI: 10.1039/b905185f)

Essential elements

New journal Chemical Science

The recent ACS Fall 2009 National Meeting in Washington was the occasion for the release of some exciting news for researchers from across the chemical sciences: invitations were distributed, an audience gathered, a few words were spoken and then the ribbon was cut, revealing the news that in 2010 a new journal – *Chemical Science* – would join the RSC portfolio.

Editorial director, James Milne, describes this new venture as a milestone in the development of the RSC publishing portfolio. ‘During recent years, RSC journals have attracted significant growth in submissions, while impact factors have increased to lead the field. The launch of *Chemical Science* will truly complement RSC Publishing’s world renowned communications and



David MacMillan cuts the ribbon to reveal RSC's new journal, *Chemical Science*

review flagship titles.’

At the forefront of the most exciting developments, and helping to define the important areas by publishing the most significant cutting-edge research,

Chemical Science will be a dedicated home for findings of exceptional significance from across ALL the chemical sciences.

Editor-in-chief David MacMillan of Princeton, US, will lead a dynamic international team of associate editors who will drive the scientific development and make decisions on the content. ‘I am extremely honoured and excited to be working with the RSC on the launch and development of *Chemical Science*,’ he says. ‘This is an opportunity to bring forward a very new type of journal and a new way of disseminating edge publications from the world of chemistry. I look forward to being part of this new approach to publishing the world’s most pioneering studies in the chemical sciences.’

*Free access to *Chemical Science* will be available – find out more at www.rsc.org/chemicalscience*

MedChemComm coming soon

MedChemComm, a new, peer-reviewed journal from RSC Publishing was announced recently at the 3rd International Symposium on Advances in Synthetic and Medicinal Chemistry in Kiev, Ukraine, and the ACS Fall 2009 National Meeting in Washington DC, US. Launching in mid 2010, the journal will focus on medicinal chemistry research, including new studies related to biologically-active chemical or biochemical entities that can act as pharmacological agents with therapeutic potential or

relevance.

The new journal will be owned by RSC Publishing and will be the official journal of the European Federation for Medicinal Chemistry (EFMC). It will complement the existing RSC Publishing portfolio of bioscience journals, providing authors in the field with a dedicated subject-specific publication. Monthly issues will contain a mix of vibrant and concise research and review articles.

The co-editors-in-chief will be Gregory Verdine, Harvard University, US, and Anthony

Wood, Pfizer, UK. Wood comments: ‘*MedChemComm* is very important, especially when one considers the mission of the journal is to emphasise the role of chemistry as a powerful vehicle to conceptualise new understanding of biological systems and processes. It is a means to design new tools to modulate these selectively by exploring multiple modalities of intervention.’

*Free access to *MedChemComm* will be available for 2010 and 2011. Find out more at www.rsc.org/medchemcomm*

Highlights in Chemical Technology (ISSN:2041-5826) is published monthly by the Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge UK CB4 0WF. It is distributed free with *Chemical Communications*, *Journal of Materials Chemistry*, *Analyst*, *Lab on a Chip*, *Journal of Atomic Absorption Spectrometry*, *Green Chemistry*, *CrystEngComm*, *Physical Chemistry Chemical Physics*, *Energy & Environmental Science* and *Analytical Abstracts*. *Highlights in Chemical Technology* can also be purchased separately. 2009 annual subscription rate: £199; US \$396. All orders accompanied by payment should be sent to Sales and Customer Services, RSC (address above). Tel +44 (0) 1223 432360, Fax +44 (0) 1223 426017 Email: sales@rsc.org

Editor: Joanne Thomson

Deputy editor: Sarah Dixon

Associate editors: Celia Gitterman, Elinor Richards

Interviews editor: Ruth Doherty

Web editors: Nicola Convine, Michael Townsend, Debra Giovannelli

Essential elements: Valerie Simpson, Daniel Bradnam, Kathryn Lees, Kathrin Hilpert

Publishing assistant: Christina Ableman

Publisher: Graham McCann

Apart from fair dealing for the purposes of research or private study for non-commercial purposes, or criticism or review, as permitted under the Copyright, Designs and Patents Act 1988 and the copyright and Related Rights Regulations 2003, this publication may only be reproduced, stored or transmitted, in any form or by any means, with the prior permission of the Publisher or in the case of reprographic reproduction in accordance with the terms of licences issued by the Copyright Licensing Agency in the UK.

US copyright law is applicable to users in the USA.

Further news...

October sees the publication of the 100th issue of the *Journal of Environmental Monitoring (JEM)*. Editor Harp Minhas, announced it a milestone event, as the journal undergoes a significant change in its subject approach. Minhas explains: ‘The impact of environmental research is of special concern to our readers. From now on all submitted articles will provide a statement explaining how the research impacts the environment directly and how the work provides insight into environmental processes.’ www.rsc.org/jem

In a separate journal development, new titles *Nanoscale* and *Analytical Methods* have published their first articles online, just months after the initial launch announcement in March.

Nanoscale, a collaborative venture with the National Center for Nanoscience and Technology, Beijing, China, publishes experimental and theoretical work across the breadth of nanoscience and nanotechnology, while *Analytical Methods* will appeal to scientists with an interest in the latest research methods demonstrating the link between fundamental and applied analytical science.

*Read the articles for free at www.rsc.org/methods and www.rsc.org/nanoscale. Register for free online access to all *Nanoscale* and *Analytical Methods* content throughout 2009 and 2010 at www.rsc.org/free_access_registration*

The Royal Society of Chemistry takes reasonable care in the preparation of this publication but does not accept liability for the consequences of any errors or omissions.

The RSC is not responsible for individual opinions expressed in *Highlights in Chemical Technology*. Content does not necessarily express the views or recommendations of the RSC.

Royal Society of Chemistry: Registered Charity No. 207890.

RSC Publishing