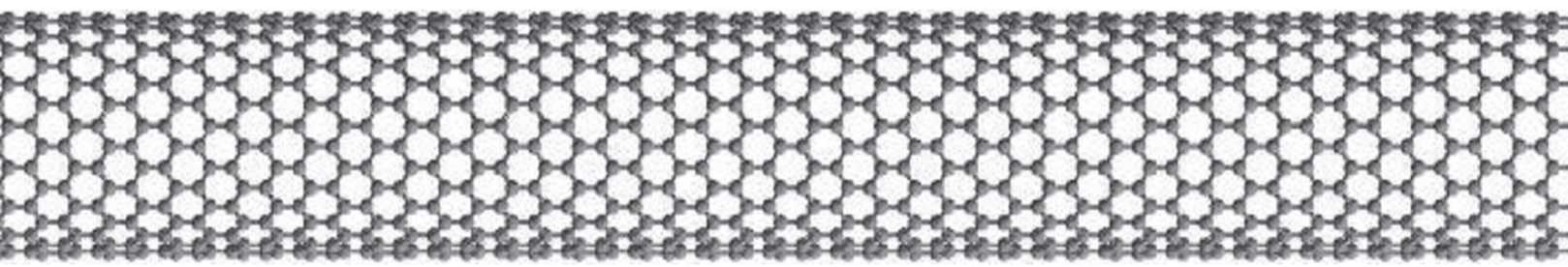
CNT@Cambridge Symposium 2007



UNIVERSITY OF
CAMBRIDGE

A Mini-Symposium on the Science and Application of Carbon Nanotubes

30 November 2007
www.cnt-cam2007.co.uk
Churchill College, Cambridge, UK

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Booklet designed by R. L. Spear

Dear delegates of CNT@Cambridge Symposium 2007,

On behalf of the CNT@Cambridge Organising Committee, I would like to welcome you to today's mini-symposium.

In Cambridge, carbon nanotube (CNT) related research has been conducted in a number of departments and divisions. Spurred by a considerably large and growing CNT community, this event was initiated in February 2007 after the founding of Carbon Nanotube Club – an online discussion group dedicated to CNT researchers and the group has recruited more than 200 members worldwide thus far. Given this backdrop, the CNT@Cambridge symposium was initiated by a group of students who share the same vision – to provide a venue for CNT researchers to exchange ideas and for industry delegates to interact with leading CNT scientists across Europe.

We are very glad that there will be representatives coming from different research institutes to share their views on the science and application of carbon nanotubes at this event. Today's talks cover a wide range of topics including synthesis, processing, some fascinating properties and applications of CNTs. Besides academic participants, we are also delighted to have support and participation from both scientific journals and the industry.

Finally, I would like to take this opportunity to express my gratitude towards our speakers, all the organising committee members and those who have helped and make this event possible. Special thanks go to our sponsors, namely Churchill College, ENSAM, Nanoholdings LLC, AIXTRON and SonicBio for their trust and financial support.

Anson Ma

Programme

9:00-9:30 **Coffee and Registration**

9:30-9:40 Welcome address
Mr. Anson Ma

9:40-10:00 Opening speech
Prof. Mark Welland

Session I **Chair: Prof. Kostas Kostarelos**

10:00-10:35 Direct spinning of carbon nanotube fibres
Prof. Alan Windle

10:35-11:10 Carbon nanotubes in motion: mechanical actuation and relaxation
Prof. Eugene Terentjev

11:10-11:45 The rheology and microstructure of carbon nanotube suspensions
Prof. Malcolm Mackley

11:45-12:20 The rheological modelling of carbon nanotube suspensions
Prof. Francisco Chinesta

12:20-13:25 **Lunch and Poster Session**

Session II **Chair: Prof. Francisco Chinesta**

13:25-14:00 Modelling electrical percolation in carbon nanotube/polymer composites
Dr. James Elliott

14:00-14:35 Carbon nanotubes - the future for electronics?
Prof. Bill Milne

14:35-15:10 Carbon nanotube cell biology and pharmacology
Prof. Kostas Kostarelos

15:10-15:40 **Tea and Poster Session**

Session III **Chair: Prof. Malcolm Mackley**

15:40-16:15 CNT-polymer nanocomposites for photovoltaics and energy storage
Prof. Gehan Amaratunga

16:15-16:50 Carbon nanotube polymer composites for high frequency electromagnetic shielding
Prof. Christian Bailly

16:50-17:25 Carbon nanotubes - the wonder material of the 21st century?
Potential applications and markets
Ms. Ottilia Saxl

17:25-18:00 Carbon nanotube photonics
Dr. Andrea Ferrari

18:00-19:00 **Cheese and Wine Reception**

Speaker Biographies

Prof. Mark Welland

Prof. Mark Wellend started his career in nanoscience and nanotechnology at IBM Research Laboratories, Yorktown Heights, USA, where he was part of the team that developed one of the first scanning tunnelling microscopes. Upon moving to Cambridge in 1985, he set up the first tunnelling microscopy group in the UK in collaboration with Prof. John Pethica. In an award by the UK Research Councils, he was made Director of an Interdisciplinary Research Collaboration in Nanotechnology. He is currently Editor-in-Chief of the Institute of Physics Journal Nanotechnology and co-chairs the recently established $200M World Premier Research Institute in Nanomaterials between the UK and Japan (NIMS, Tsukuba). In 2002, he gave the Turing Lecture and in 2003 presented the Sterling Lecture series in India and this year gave the Annual Max Planck Society lecture in Stuttgart. He has appeared before the British Government's Science and Technology select committee and has given seminars to the European Parliament. In addition to his scientific work he has been involved in a number of reports dealing with the societal, ethical and environmental issues of nanotechnology and was a member of the Royal Society/Royal Academy of Engineering Nanotechnology Study Working Group that reported to the UK Government in July 2004. He is currently a member of the Advisory Committee on Hazardous Substances set up by Defra and advises several international governments and Research Institutions on nanotechnology. He has taken part in many television and radio programmes for the BBC, SKY, Open University and University of the Air, Japan and written articles for the Guardian, FT and The Times.

Prof. Alan Windle

Prof. Alan Windle is the Director of the Pfizer Institute for Pharmaceutical Materials Science and leads the Macromolecular Materials Laboratory in the Materials Science and Metallurgy Department of the University of Cambridge. He is also the Chairman of the Board of Q-Flo, a company designed to develop innovations in materials nanotechnology. Prof. Windle obtained his Engineering degree in Metallurgy from Imperial College, London and his PhD from the University of Cambridge. He became interested in polymers while working with Andrew Keller in the Physics Department at the University of Bristol. Upon returning to Cambridge in 1975, he established the Macromolecular Materials Laboratory, concentrating initially on the structure of non-crystalline polymers and more recently on synthesis and applications of carbon nanotubes and their composites. Prof. Windle holds the Bessemer and Royal Society of Arts Silver Medal from Imperial College. He was awarded the Rosenhain Medal by the Institute of Metals and the Swinburne Gold Medal and prize by the Plastics and Rubber Institute. In 2007, he received the Royal Society Armourers and Braziers Medal as well as the Founders' Prize of the Polymer Physics Group. He was closely involved in the founding of Cambridge Molecular Design, a materials software company, and of the Melville Laboratory for Polymer Synthesis at Cambridge. He was also the Executive Director of the Cambridge-MIT Institute during its formative years. He has published over 300 papers in the areas of polymer physics, liquid crystalline polymers, computational modelling and carbon nanotubes.

Speaker Biographies

Prof. Eugene Terentjev

Prof. Eugene Terentjev is a Professor of Polymer Physics at the Cavendish Laboratory, University of Cambridge and fellow of Queens' College. After studying and receiving his PhD (1985) in Moscow, and working in the Institute of Crystallography, Russian Academy of Sciences, he became a research associate at Case Western Reserve University in Cleveland, Ohio (1990-1992). He has been in Cambridge since 1992, progressing from a research associate to an EPSRC Advanced Fellow, and subsequently to a faculty member. His research includes theory and experimental studies and mainly focuses on structure and dynamical properties of soft matter: polymers, liquid crystals, composites and colloids – with an increasing interest in self-assembly and function of biological materials. Prof. Terentjev is an editor of the Springer series *Advances in Polymer Physics* and several collections, and an author of the monograph *Liquid Crystal Elastomers*.

Prof. Malcolm Mackley

Prof. Malcolm Mackley obtained his BSc in Physics from the University of Leicester, his MSc in the Physics of Materials from the University of Bristol and his PhD in Polymer Physics from the University of Bristol. He is the Professor of Process Innovation and Head of the Polymer Fluids Group in the Department of Chemical Engineering at the University of Cambridge. His research group studies both complex fluids and complex flows. Prof. Mackley has been a key figure in the British Society of Rheology for many years. In 2002 he was awarded the British Society of Rheology Annual award for his work on the rheology and processing of polymer molecules. He was elected as a Fellow of the Royal Academy of Engineering (FREng) in 2003 and was recently appointed the President of the British Society of Rheology.

Dr. Andrea C. Ferrari

Dr. Andrea C. Ferrari is a University Lecturer in Electrical Engineering and a Royal Society University research fellow. He is also a Fellow of Pembroke College. His research interests combine nanomaterials growth, modelling, characterisation and devices. In particular, he has studied growth and characterization of diamond-like carbon nanotubes and nanowires for coating, optoelectronics and sensing applications. He is working on the non-linear optical properties of nanotubes for applications in photonic devices. The experimental activity is paralleled by first principles calculations and modelling. He is the author of more than 110 papers and 230 presentations (55 of which were invited).

Speaker Biographies

Dr. James Elliott

Dr. James Elliott is a University Lecturer in Materials Modelling at the University of Cambridge. He received his MA in Natural Sciences in Physics and Theoretical Physics from the University of Cambridge and his PhD in Polymer Physics from the University of Bristol. In 1998, he joined the Macromolecular Materials Laboratory in the Materials Science and Metallurgy Department where he investigated the physics of aggregation in polymer composites and collapse behaviour of carbon nanotubes under pressure. In 2002, he was elected a fellow of Fitzwilliam College, Cambridge in the positions of Director of Studies and College Lecturer in Materials Science. He has been a member of the Institute of Physics since 2000, attaining Chartered Scientist (CSci) status in 2004.

Prof. Bill Milne

Prof. Bill Milne FREng is Director of the Centre for Advanced Photonics and Electronics (CAPE) and has been Head of Electrical Engineering at Cambridge University since 1999. He was appointed to the "1944 Chair in Electrical Engineering" in 1996. He was elected to a Fellowship of the Royal Academy of Engineering in 2006. His research interests include large area Si and carbon based electronics, thin film materials and, most recently, MEMS and carbon nanotubes and other 1-D structures for electronic applications. He collaborates with various companies including Dow-Corning, ALPS, Thales, Advance Nanotech, Philips and FEI and is also currently involved in 5 EU projects and several UK Government funded EPSRC projects and has recently become involved in a major collaboration with various groups in South Korea for work on biosensors. He has published/presented ~ 600 papers in these areas, of which greater than 120 were invited.

Prof. Kostas Kostarelos

Prof. Kostas Kostarelos is the Chair of Nanomedicine at The School of Pharmacy of the University of London, a Fellow of the Royal Society of Medicine (FRSM) and a Fellow of the Institute of Nanotechnology (FIoN). He obtained his Diploma in Chemical Engineering and PhD from the Department of Chemical Engineering, Imperial College, London. Following his promotion to Assistant Professor of Genetic Medicine and Chemical Engineering in Medicine at Cornell University Weill Medical College, he relocated to the UK as the Deputy Director of Imperial College Genetic Therapies Centre. Prof. Kostarelos is the Deputy Head of the Centre for Drug Delivery Research and Co-Director of the MSc in Drug Delivery. He is a Senior Founding Member of the American Academy of Nanomedicine (Washington DC, USA) and the Treasurer and Board Member of the International Liposome Society (Vancouver, Canada). Prof. Kostarelos sits on the Editorial Board of: The Journal of Liposome Research and The International Journal of Nanomedicine.

Speaker Biographies

Prof. Gehan Amaratunga

Prof. Gehan Amaratunga FREng., FIEE, CEng. obtained his B.Sc (1979) from Cardiff University and Ph.D (1983) from Cambridge, both in electrical/electronic engineering. He has held a Professorship in Engineering at the University of Cambridge since 1998. He currently heads the Electronics, Power and Energy Conversion Group, one of four major research groups within the Electrical Engineering Division of the Cambridge Engineering Faculty. He has worked for 23 years on integrated and discrete electronic devices for power conversion; and on the science and technology of carbon based electronics for 20 years. He has an active research programme on the synthesis and electronic applications of carbon nanotubes and other nanoscale materials. His group has many 'firsts' emanating from his research in carbon, including field emission from N-doped thin film amorphous carbon and diamond, laboratory synthesis of carbon nanonions, tetrahedral amorphous carbon ('amorphous diamond')-Si heterojunctions, deterministic growth of single isolated carbon nanotubes in devices, high current nanotube field emitters and the polymer-nanotube composite solar cells. He also has research interest in nanomagnetic materials for spin transport devices. He has previously held faculty positions at the Universities of Liverpool (Chair in Electrical Engineering), Cambridge, and Southampton. He has held the UK Royal Academy of Engineering Overseas Research Award at Stanford University and has been a Royal Society visitor at the School of Physics, University of Sydney. He has published over 450 journal and conference papers. Professor Amaratunga was elected a Fellow of the Royal Academy of Engineering in 2004. In 2007, he was awarded the Royal Academy of Engineering Silver Medal 'for outstanding personal contributions to British engineering'.

Prof. Christian Bailly

Prof. Christian Bailly is a Full Professor at Université catholique de Louvain (UCL) in Louvain la Neuve, Belgium. He obtained his PhD in Polymer Science in 1983 at UCL. After working in 1984-1985 as Research Associate at the University of Massachusetts, Amherst, USA, in the team of Profs. W. McKnight and F. Karasz, he joined General Electric Plastics, Bergen op Zoom, the Netherlands, and GE Corporate R&D, Schenectady, NY, USA. Two of his major research areas at that time were the reactive compatibilization of polymer blends and the melt synthesis of polycarbonate. He next moved back to Belgium as a tenured Professor at UCL in 1998. His current research interests focus on the influence of macromolecular and supramolecular architecture on the rheology of entangled melts and solutions and the structure-property relationships of multiphasic polymer systems, including nanocomposites.

Speaker Biographies

Ms. Ottilia Saxl

Ms. Saxl is the founder and CEO of the Institute of Nanotechnology (IoN), a registered charity. Ms. Saxl has organised several fact finding missions to major nanotechnology centres across Europe and the USA, and she has served on several UK and EU nanotechnology panels. Presently she is a member of DEFRA's Nanotechnology Stakeholder Panel, the European Technology Platform on NanoMedicine, and the Human Performance Enhancement working group of NanoBioRaise. She is a contributor to both the International Risk Governance Council's White Paper on Nanotechnology Risk Governance and to the ESF publication 'Forward Look Nanomedicine'. She has also talked about new technologies on several radio and television programmes, most recently discussing smart textiles on BBC Radio's Women's Hour.

Prof. Francisco Chinesta

Prof. Francisco Chinesta obtained his M.S. in Mechanical Engineering (1990) and later his Ph.D. (1993) from the University of Valencia, Spain. He is currently the Prof. of Computational Mechanics and Director of the Laboratory of Mechanics of Systems and Processes (LMSP), a joint research laboratory of the CNRS (French National Foundation of Science) and the ENSAM (High School of Engineering). He also directs the Mechanical Engineering Department in ENSAM, Paris. Prof. Chinesta is the author of around 350 scientific works, with more than 100 papers in scientific journals, with 20 contributions to research books and about 200 contributions to conference proceedings. He was the winner of the European Scientific Association on Material Forming (ESAFORM) award in 2000. He is the editor-in-chief for the International Journal of Forming Processes and serves on the board of directions for different scientific associations such as the scientific committee of the European Journal of Computational Mechanics, Applied Rheology and Archives of Computational Methods in Engineering. He has helped organise more than 50 conferences. His research interests lie in novel and advanced computational techniques for simulating solid and fluid mechanics, numerical modelling of forming processes involving complex flows and fluids such as suspensions, polymer solutions, entangled polymers, liquid crystalline polymers and nanostructured materials, and the development of accurate numerical strategies for solving multiscale, multiphysical and multidimensional models typically encountered in the modeling of complex fluids and flows.

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*As of 1 November 2007

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HISTORY

Grande Ecole was founded in 1780 by the Duke of La Rochefoucauld-Liancourt. ENSAM has trained more than 78 000 engineers who have taken part in the industrial development of France.

ENSAM is a state institution of scientific, cultural and professional nature placed under the authority of the French Ministry in charge of higher education.

3 MAJOR FIELDS OF STUDY AND RESEARCH

1. Mechanics, materials, manufacturing processes
2. Fluid mechanics, energy systems
3. Design, industrialisation, risk, decision making

KEY FIGURES

4000 students including 400 international students

1000 undergraduate students
2200 graduate students
600 students in continuing education and postgraduate specialised year
200 PhD students

Staff

600 academics and experts from industry
620 administrative and technical staff
250 full-time research staff in 22 research laboratories

CONTACT DETAILS

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NanoHoldings LLC is an industry-leading, USA-based, venture capital company. We provide innovation capital and commercialisation assistance to world-leading nanotechnology research groups. Our partner Universities include the Universities of Cambridge, Rice and Yale.

NanoHoldings LLC is interested in any nanotechnology innovation with world changing potential. Of particular interest to us are those nanotechnology innovations that might help address the energy challenges of this century.

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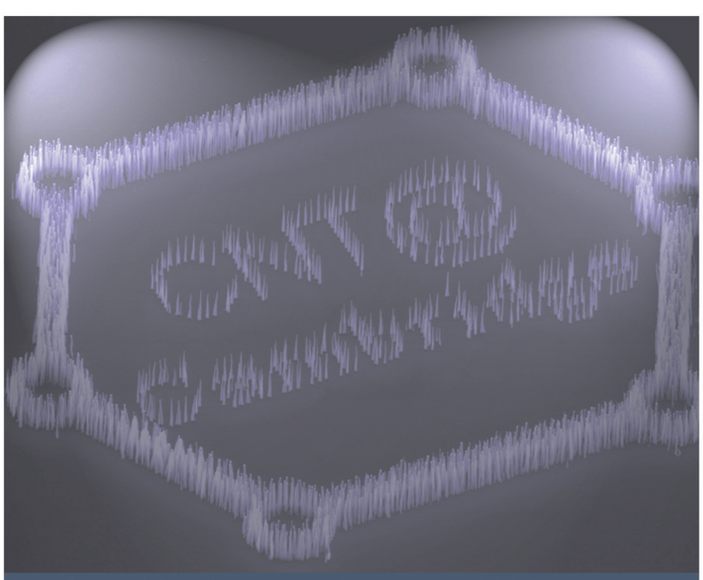

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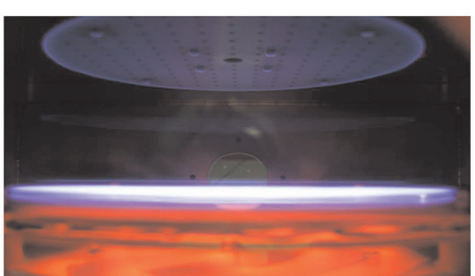

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- Regulating the temperature during the mixing process

If you need further information or if you would like to arrange for a drop-in demonstration, please feel free to contact our team at: +32 4 364 20 50 or info@sonicbio.com

Special Acknowledgements

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