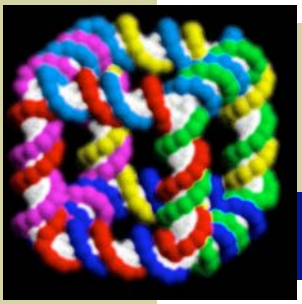


ISNSCE Newsletter

Newsletter June 2005

Volume 1, Issue 2

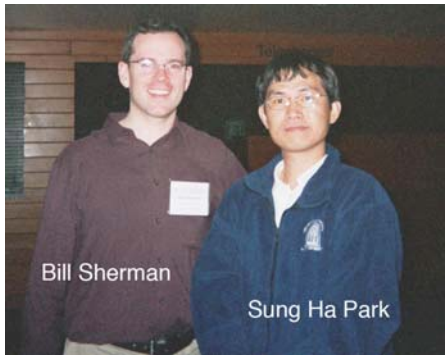
Report from the meeting FNANO'05

Foundation of Nanoscience 2nd Annual Conference (FNANO05)

Written by Hao Yan & William Sherman

The 2nd annual conference on Foundations of Nanoscience, chaired by John H. Reif, was held from April 24 to 28, 2005 in Snowbird, Utah. Following on the success of the first FNANO conference in 2004, many leading researchers from around the world attended, but the conference retained its warm and friendly atmosphere. No doubt some were disappointed that the number of talks was kept fairly low. However, this allowed generous amounts of time for frequent poster sessions and food breaks, and provided an ideal environment for networking and discussion.

Self-assembly continues to be the central theme of the conference. Topics include self-assembled architectures and devices, at scales ranging from nano-scale to meso-scale. The conference spans traditional disciplines including chemistry, biochemistry, physics, computer science, mathematics, and various engineering disciplines including MEMS. This year's conference was co-sponsored by the Defense Advanced Research Projects Agency (DARPA) and the International Society for Nanoscale Science, Computation and Engineering (ISNSCE).



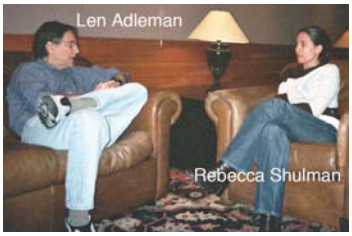
The FNANO05 program was organized around 13 different tracks and featured 67 talks, most of which were invited, and 45 posters. The tracks included: Self-assembled surface chemistry, nano-optics, principles and theory of self-assembly, self-assembly across scales, peptide self-assembly, viral self-assembly, molecular electronics devices, molecular electronic circuit assembly, self-assembled DNA nanostructures, DNA linked nanoparticle structures, molecular motors, molecular electronics architectures, and fullerene nanostructures. Impressively well-controlled synthesis techniques are being

Inside:

developed for 1 and 2 dimensional systems. Xiaogang Peng presented simple techniques for producing multilayered colloidal nanocrystals with each layer having controlled stoichiometry. Peidong Yang described an exciting development of assembling ultralong crystalline oxide nanoribbons for subwavelength optical waveguide devices. Marya Lieberman presented cutting edge lithography techniques based on molecular lift-off.

More complex structures are also being devised based on a variety of different synthetic strategies. Luc Jaeger discussed the use of RNA tectonics to build arbitrary nano-scale shapes. He illustrated the technique by showing numerous AFM micrographs of heart-shaped molecules self assembled from 4 RNA molecules. Jonathan Malo, from Andrew Turberfield's group, presented impressive results of using a self-assembled DNA lattice to scaffold Ruv A protein. Philip Dawson reported on state of the art techniques for chemical synthesis of polypeptides reaching up to hundreds of peptides in length in many cases and with potential for the incorporation of non-natural chemical groups.

Various nano-devices were presented, of which the simplest was depicted in Ben Feringa's beautiful movie of a rocket-like micro-crystallite shooting around in hydrogen peroxide, a steady stream of expanding bubbles pushing it forward as the hydrogen-peroxidase on its surface catalyzed the formation of oxygen. Feringa also presented a variety of light driven molecular rotors his group has been synthesizing with ever increasing versatility and effectiveness. An assortment of nucleic acid walkers were also reported, with Andrew Turberfield presenting different strategies for powering walkers, Chengde Mao presenting a 'crawler' that slowly moves along a track, cleaving RNA strands as it moves along, and Niles Pierce presenting data on how load bearing affects the speed of his DNA based bipeds.



Beyond the issue of synthesis, however, a recurring theme in the meeting was the discussion of pitfalls in nanoscience. Ranganathan Shashidhar spoke about how measurements of molecular electronics are often influenced by the specific experimental setups being used and reported observing significant variations when the same properties were measured using different electrode materials or configurations. Later in the week, Stuart Lindsay, Rick McCreery and Amar Flood all emphasized the variation of observed properties of molecular electronic devices when the measurements are carried out in assorted phases and molecular environments. Toward the end of the meeting,

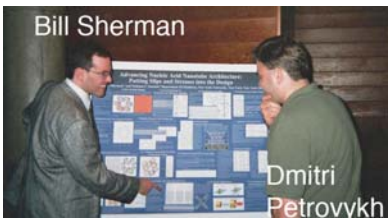
Craig Lent pointed out that if the anticipated high-density nano-circuitry were ever built using conducting circuit elements, the heat buildup would be excessive. He discussed strategies for using quantum dot cellular automata based systems to minimize heat production. Many of the presentations emphasized methods for allowing for system errors. Erik Winfree presented a beautiful illustration of how to build an algorithmically self-assembling system that can correct errors that may be introduced into the structure by external irritants. Seth Goldstein presented a novel computer architecture that would be error-tolerant by virtue of being reconfigureable: the wire connections would be assignable after formation of the circuit, so defective elements could be bypassed.

Other talks spoke of how to take advantage of the "flaws" in a system. Paul Weiss gave a fascinating talk on self-assembled monolayers. He presented methods for creating, identifying and manipulating defects in the layers to controllably manufacture an assortment of different types of surface features. Rebecca Schulman, from Erik Winfree's Lab presented an evolutionary synthesis strategy that was based on the slow occurrence of errors in the growth of DNA tiled arrays. Moisset de Espanes related a quite entertaining story of how he found the minimal number of tiles that can be used as self-assembling counters. His method only worked because his computer algorithms accepted good but flawed structures that could be manually adjusted in small ways to generate the optimal solution.

Besides the exciting scientific program, two workshops were also held during the evening sessions. The first one featured topics in nanoscience business and consisted of brief presentations and interactive Q&A with the audience led by a panel of corporate officers from a number of venture capital companies investing in nanotechnology. The second workshop was an NSF sponsored competition that gave conference attendees an opportunity to present their thoughts on the foremost challenges and directions of the field. Philip Kuekes was voted the winner for his proposal that nanoscientists endeavor to learn lessons from biology and biological styles of synthesis.

The conference also included an open meeting of the ISNSCE. President Nadrian Seeman emphasized that the new organization was not focused in any one country, but was intended to be a truly international organization. He encouraged people to join and to help get involved in running the society.

FNANO05 was uniformly regarded as a great success. The FNANO conference provides a synergism for a community of scholars working in self-assembly related areas to interact with each other. There were many more exciting presentations beyond what is mentioned here, including, in particular, a great deal of theoretical work, and experiments in micron scale self-assembly. This meeting will surely grow rapidly in upcoming years, hopefully without losing its engaging camaraderie and collaborative environment.



From the Nominating Committee

The next year (2006) the ISNSCE President will be our current Vice President, Prof. Grzegorz Rozenberg. So, the next year's Vice President position is up for election. The person elected for the Vice President will serve as President the year after (2007).

The nominating committee has identified two candidates that are presented to the ISNSCE members, **Prof. James K. Gimzewski** and **Prof. Andrew J. Turberfield.** All members are eligible to vote and ballots will be distributed later in the Summer. With this Newsletter we introduce the candidates to the members.

Chengde Mao, on behalf of the ISNSCE nominating committee

James K. Gimzewski

Birth year: 1951

BS and PhD degrees:

1977 Ph.D. in Physical Chemistry, University of Strathclyde, Glasgow, Scotland, UK

1974 B.Sc. (Hons) in Pure Chemistry, Upper Second, University of Strathclyde, Glasgow, Scotland

Positions: 2001- Professor of Chemistry, University of California, Los Angeles**;** 1983-2001 Research Staff Member and Project Leader in Nanoscale Science, IBM Research Division, IBM Zurich Research Laboratory, Rüschlikon, Switzerland; 1979-1983 Post-Doctoral Research Fellow: Plasma-Surface Interactions Group, Institute of Inorganic Chemistry, University of Zurich, Switzerland; 1977-Post-Doctoral Research Fellow: The Radiation Center, Oregon State University.

Awards and recognitions: 2001 *Dudell Medal and Prize* for contribution to Nanoscale science, Institute of Physics, London; 2001 *Guinness World Records* recognition for the smallest calculator; 1998 *The 'Wired 25' Award*, Wired magazine, The Paramour, Los Angeles; 1997 *Awarded the Feynman Prize in Nanotechnology for Experimental Work* Feynman Prize Committee and the Foresight Institute, Palo Alto, CA; 1997 *The Discover Award for Emerging Fields (Nanotechnology) Epcot* 1997 *IBM Outstanding Innovation Award* in appreciation for Engineering Single Molecules.

Representative publications: (1) "Observation of nuclear fusion driven by a pyroelectric crystal," B. Naranjo, J. K. Gimzewski and S. Putterman.Nature, 434, 1115-1117 (2005). (2) "Local Nanomechanical Motion of the Cell Wall of *Saccharomyces cerevisiae*," A. E. Pelling, S.Sehati, E. B. Gralla, J. S. Valentine, and J. K. Gimzewski. Science, 305, 1147-1150 (2004). (3) "Direct Determination of the Energy Required to Operate a Single Molecule Switch" Ch. Loppacher, M. Bammerlin, M. Guggisberg, E. Meyer, H.J. Güntherodt, R. Lüthi, R. Schlittler, J.K. Gimzewski, H. Tang, and C. Joachim Phys. Rev. Lett, 90, 66107-1-4 (2003). (4) **"**The Nanoneme Syndrome: Blurring of fact and fiction in the construction of a new science," J. Gimzewski, V. Vesna. Technoetic Arts, 1, 7-24 (2003). (5) "Electronics using hybrid-molecular and mono-molecular devices" C. Joachim, J.K. Gimzewski, A., Avriam,Nature, 408, 541-548 (2000).

Professional Affiliations: 2005 Founding Member America Association for Nanomedicine (AANM); 2005 Member New York Academy of Sciences; 2002 Elected Fellow of the World Innovation Foundation; 2002 Elected co-director of Center for Social Interfaces & Networks Advanced Programming Simulations & Environments (SINAPSE), UCLA; 2001 Elected Fellow Royal Academy of Engineering, London, United Kingdom (FREng); 1997 Awarded status of 'Founder' of the Institute of Nanotechnology, UK; 1996 Invited STA Fellow National Institute for Metals (NRIM), Tsukuba, Japan; 1995 Elected Fellow of the Institute of Physics (FinstP), London,UK; 1995 Awarded title of Chartered Physicist (CPhys).
Research interest: In the field of nanoscience, I have been particularly interested in nanomechanics applied to systems varying from single molecules up to living cells. My research also has taken a focus on exploration of medical applications that have potential for diagnostic or therapeutic applications. The understanding of complexity in creating functional systems in a stochastic fluctuating background is also fascinating and bacterial systems are currently an area of research interest. My research continues to be inspired by probe microscopes and micromechanical sensors which I have recently adapted for the production of Xrays, ions, electrons and even neutron beams. I very much enjoy engaging on the fusion of art and science and continue to create installations designed to engage the public in nanotechnology.
Personal statement: Nanotechnology is not an option for our future. It is a necessity, as energy (oil) and medical care costs continue to escalate beyond global sustainability . We will find ourselves in an entirely new world, with very different values and motivations. Nanotechnology, with its enormous and global implications, will also face fierce opposition from those who have invested in the old, mechanistic, world-view prevalent today. We have witnessed, in the 20th century, many great innovations have been squashed by corporate, industrial and national interests – transportation and energy being at the top of the list. It appears that resistance to a technology that will change fundamentally the way humans think, may be much greater, given the usual time period of 20-50 years it takes for technology to penetrate into the general society. We are about to witness some great ideological struggles, much greater than seen in past centuries. As scientists we have an obligation to engage in the public debate and maintain an openness to ensure that Nanotechnology evolves for global societal benefit of humankind.

Andrew J. Tuberfield

Birth year: 1961

MA and PhD degrees:
1983 *MA* (Cantab) in Natural Sciences
1988 *D.Phil.* (Oxon)

Positions held: 2002 - Professor of Physics, University of Oxford and Magdalen College, Oxford, UK University; 1998-2002 Reader in Physics; 1992-1998 Lecturer in Physics; 1990-1992 University College, Oxford, UK Temporary University Lecturer; 1986-1990 Christ Church, Oxford, UK , Research Lecturer
Awards and recognitions: 2001-2006 Senior Research Fellow of the Engineering and Physical Sciences Research Council

Representative publications: (1) ``Engineering a 2D Protein-DNA Crystal" J Malo, J. C. Mitchell, C. Vénien-Bryan, J. R. Harris, H. Wille, D. J. Sherratt, A. J. Turberfield, Angewandte Chemie Int. Ed. 44, 3057 (2005); (2) ``DNA Fuel for Free-Running Nanomachines" A. J. Turberfield, J. C. Mitchell, B. Yurke, A. P. Mills, Jr., M. I. Blakey and F. C. Simmel Phys. Rev. Lett. 90, 118102 (2003) (3) ``A DNA-fuelled molecular machine made of DNA" B. Yurke, A.J. Turberfield, A.P. Mills, Jr., F.C. Simmel and J.L. Neumann, Nature 406, 605 (2000); (4) ``Fabrication of photonic crystals for the visible spectrum by holographic lithography" M. Campbell, D.N. Sharp, M.T. Harrison, R.G. Denning and A.J. Turberfield Nature 404, 53 (2000).
Professional affiliations: Fellow of the Institute of Physics
Member, ISNSCE and MRS
Research interest: Biomolecular self-assembly (DNA nanostructures) Microstructured optical materials (photonic crystals)
Personal statement: The Society is a bridge between communities - it is international and cross-disciplinary, as is reflected in the conference series (FNANO and DNA Computing) that it suports. This is the strength of the Society - as it develops it must keep this role. I hope to see the Society grow - it is still much smaller than its potential membership. If elected I would explore the possibility of collaboration between ISNSCE and other professional societies, through joint membership and jointly-run meetings. I hope that, as the Society grows in size and influence, it will be able to provide more support for young researchers, especially those working at the boundaries between traditional subjects.

The Program from DNA11

The full report comes in next newsletter

The 11th International Meeting on DNA Computing (June 6-9, 2005) London, Ontario, Canada

Monday, June 6. Tutorials

9:00-10:30 Computer science for life science researchers
Mark Daley

10:30-11:00 Coffee break

11:00-12:30 Molecular biology for computer scientists
Junghuei Chen

12:30-14:30 Lunch break

14:30-16:00 DNA nanotechnology
Ned Seeman

18:00 Reception (in Grad Club, Middlesex College)

Tuesday, June 7

Session Chairs: Niles Pierce & Byoung-Tak Zhang
9:00-9:55 Robotic self-organization Eric Klavins (invited)

10:00-10:25 Algorithmic self-assembly of a binary counter using DNA tiles
Robert Barish, Paul W. K. Rothemund and Erik Winfree

10:25-10:50 Complexity of graph self-assembly in accretive systems and self-destructible systems John H. Reif, Sudheer Sahu and Peng Yin

10:50-11:10 Coffee break

11:10-11:35 Use of DNA nanodevices in modulating the mechanical properties of polyacrylamide gels Bernard Yurke, David C. Lin and Noshir A. Langrana

11:35-12:00 Control of DNA molecules on a microscopic bead using optical techniques for photonic DNA memory Yusuke Ogura, Taro Beppu, Masahiro Takinoue, Akira Suyama and Jun Tanida

12:00-12:25 Single nucleotide polymorphism-based DNA computing in an İntegrated microfluidic processor William H. Grover and Richard A. Mathies

12:25-12:50 Conference photo (in front of Middlesex College)
12:50 Conference excursion

Wednesday, June 8

Session Chairs: Ned Seeman & Masayuki Yamamura
9:00-9:55 Nanomechanical probes of biosystems
James Gimzewski (invited)

10:00-10:25 Intensive in vitro experiments of implementing and executing finite automata in test tube Junna Kuramochi and Yasubumi Sakakibara

10:25-10:50 A poor man's microfluidic DNA computer Danny van Noort

10:50-11:10 Coffee break

11:10-11:35 Linearizer and Doubler: Two mappings to unify molecular computing models based on DNA complementarity Kaoru Onodera and Takashi Yokomori

11:35-12:00 Recognizing DNA splicing Matteo Cavaliere, Natasha Jonoska and Peter Leupold

12:00-12:25 On bounded symport/antiport P systems
Oscar H. Ibarra and Sara Woodworth

12:25-14:00 Lunch break

Session chairs: Junghuei Chen & Erik Winfree
14:00-14:55 Bacterial intelligence and DNA computing
Eshel Ben-Jacob (invited)

15:00-15:25 Development of an in vivo computer based on Escherichia coli
Hirotaka Nakagawa, Kensaku Sakamoto and Yasubumi Sakakibara

15:25-15:50 Counting time in computing with cells
Oscar H. Ibarra and Andrei Paun

15:50-16:10 Coffee break

16:10-16:35 A DNAzyme crawls along a one-dimensional track
Ye Tian, Yu He, Yi Chen and Chengde Mao

16:35-17:00 Photo- and thermoregulation of DNA nanomachines
Keiichiro Takahashi, Satsuki Yaegashi, Hiroyuki Asanuma and Masami Hagiya

17:00-19:00 Poster session

19:00 Conference banquet

Thursday, June 9

Session Chairs: John Reif & Paul Rothemund
9:00-9:55 Translating DNA words into actions
Perh Harbury (invited)

10:00-10:25 Error correction for DNA self-assembly: Preventing facet nucleation
Ho-Lin Chen, Ashish Goel, Rebecca Schulman and Erik Winfree

10:25-10:50 Complexity of compact proofreading for self-assembled patterns
David Soloveichik and Erik Winfree

10:50-11:10 Coffee break

11:10-11:35 A microfluidic device for DNA tile self-assembly
Koutaro Somei, Shohei Kaneda, Teruo Fujii and Satoshi Murata

11:35-12:00 Expectation and variance of self-assembled graph structures
Natasha Jonoska, Gregory McColm and Ana Staninska

12:00-12:25 A self-assembly model of time-dependent glue strength
Sudheer Sahu, Peng Yin and John H. Reif

12:25-14:00 Lunch break

Session Chairs: Takashi Yokomori & Anne Condon
14:00-14:55 DNA as the raw material for general-purpose electrical biosensors
Dipankar Sen (invited)

15:00-15:25 Two proteins for the price of one: The design of maximally compressed coding sequences Bei Wang, Dimitris Papamichail, Steffen Mueller and Steven Skiena

15:25-15:50 Simple operations for gene assembly
Tero Harju, Ion Petre, Vladimir Rogojin and Grzegorz Rozenberg

15:50-16:10 Coffee break

16:10-16:35 Sequence complexity of large libraries of DNA oligonucleotides
Junghuei Chen, Russell Deaton, Max Garzon, Jin Woo Kim, David H. Wood, Hong Bi, Dylan Carpenter, Ju Seok Le and Yu-Zhen Wang

16:35-17:00 Molecular learning of wDNF formulae
Byoung-Tak Zhang and Ha-Young Jang

17:00-18:00 Closing Meeting