Tuesday Morning, November 4, 2003

AVS 50th Anniversary Plenary Session
Room 310 - Session AP-TuM

Information

Moderator: M. Grunze, Universität Heidelberg, Germany

8:20am **AP-TuM1 Light Optical Nanoscopy in Cellular Biophysics**, ***C. Cremer***, *U. Spoeri, A.V. Failla, B. Albrecht, Ch. Wagner, A. Schweitzer, L. Hildenbrand, I. Upmann, J. Rauch, G. Kreth, N. Kepper, Ch. Engelbrecht,* Univ. of Heidelberg, Germany*; A. Rapp,* Inst. for Molecular Biotech., Germany*; M. Hausmann,* Univ. of Freiburg, Germany*; D. Toomre,* Yale Univ.*; S. Martin, A. Pombo,* Medical Res. Council, UK*; T. Cremer,* Univ. of Munich, Germany **INVITED**

For many studies in cellular biophysics, it is highly desirable to develop optical methods for the analysis of specific biological nanostructures in the interior of three-dimensionally conserved cells. Here, important structural parameters to be considered are topology, i.e. mutual positions and distances of constituting subunits, as well as information about the size of such objects. In the low energy range, this has become possible by development of novel methods of far-field light fluorescence microscopy. Spectral Precision Distance Microscopy [SPDM] is based on labelling of neighbouring objects with different spectral signatures, spectrally selective registration, high precision position monitoring, and careful calibration of chromatic aberrations, cross talk etc. In combination with confocal laser scanning microscopy, SPDM allowed the measurement of spatial positions and mutual distances ("topology") of DNA sequences in specific human nuclear gene domains down to the 30 - 50-nanometer range. Theoretical considerations supported by "Virtual Microscopy" computer simulations indicated that using "Point Spread Function (PSF) Engineering" approaches with a suitably modified PSF, even at the fluorescence photon count number typical for single molecule fluorescence emission, a topological resolution limit down to the few-nanometer range with a precision in the subnanometer range might become feasible. For example, Spatially Modulated Illumination [SMI] far field light microscopy provides a PSF with the required properties; presently, experimental distance measurements in the direction of the optical axis down to the few nanometer scale, with a precision in the one-nanometer range (about 1/500 of the exciting wavelength) have been realized. Furthermore, SMI-approaches have been used to measure the diameter of individual fluorescent targets down to a few tens of nanometer, corresponding to about 1/16 of the exciting wavelength used.

9:00am **AP-TuM3 Biological Applications of Micro and Nanoscale Devices**, ***H.G. Craighead***, Cornell University **INVITED**

Micro and nanoscale technologies are providing new possibilities for investigating life processes at the sub-cellular and molecular level. Electrical and optical probes can be constructed to enable increasingly fine scale resolution of the dynamic processes taking place in living systems. Similar approaches are allowing for analysis of increasingly small amount of biochemicals with the ultimate limit of single molecule analysis being seriously considered. Methods of fabricating micro and nanoscale interfaces with controlled structure and chemical composition are also providing vehicles for exploring the response of living cells to their environment. These same technologies may be exploited for a new biotechnology, making greater utility of active biomolecules combined with electronic and optical devices. This talk will explore some of the activity in the development of these new biological tools and approaches.

9:40am **AP-TuM5 Atomic-scale Device Fabrication in Silicon**, ***M.Y. Simmons***, University of New South Wales, Australia **INVITED**

Over the past three decades the driving force behind the expansion of the microelectronics industry has been the ability to pack ever more features onto a silicon chip, achieved by continually miniaturising the size of the individual components. However, after 2015 there is no known technological route to reduce device sizes below 10nm. We demonstrate a radical new technology for atomic-scale (0.1nm) device fabrication in silicon using a combination of scanning tunnelling microscopy and atomic precision crystal growth. In particular we focus on the ability to place individual phosphorus atoms in silicon at precise locations and encapsulate them in epitaxial silicon with minimal diffusion and segregation of the dopants. We present results demonstrating the power of this approach both towards the controlled fabrication of atomic-scale devices in silicon, and towards the construction of a solid-state silicon based quantum computer.

10:20am **AP-TuM7 Nanometer Computing**, ***S.C. Goldstein***, Carnegie Mellon University **INVITED**

The continuation of the remarkable exponential increases in processing power over the recent past faces imminent challenges due in part rising cost of design and manufacturing and the physics of deep-submicron semiconductor devices. A promising solution to these problems is offered by an alternative to CMOS-based computing, chemically assembled electronic nanotechnology (CAEN). In this talk we discuss the challenges and opportunities posed by CAEN-based computing. We briefly describe recent work in CAEN from the prospective of a computer architecture. The challenges arise from the set of assembly primitives inherent in bottom-up manufacturing. These primitives all but eliminate the ability to create arbitrary connections between devices. The manufacturing methods also imply defect densities which are significantly higher than today's. We show how molecular devices and post-manufacturing reconfiguration can overcome both these obstacles.

11:00am **AP-TuM9 Electronic Materials in the 21st Century: Is the Future Different from the Past?**, ***H.L. Stormer***, Columbia University and Bell Labs, Lucent Technologies **INVITED**

The 20 century may well go into history books of technology as the century of the silicon chip. Silicon and its siblings, the III-V semiconductors, are unquestionably dominating electronics and photonics as we know them. These are just a handful of elements from the periodic table. Why these? What makes them so successful? Are there things they cannot do? Could we overcome such limitations by reaching out to other elements? Which ones and why? Nobody has good answers to these technologically and economically extraordinary important questions. But we can speculate.

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