IUPAP Commission 17

Quantum Electronics

Working Group on Nanoscience

Richart E. Slusher
Szeged, Hungary

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Commission Conferences

IQEC (International Quantum Electronics Conference)
- Moscow, Russia 2002
- Tokyo, Japan, 2005

International Symposium "Modern Problems of Laser Physics"
- Novosibirsk, Russia 2004
Session Titles at IQEC 2005

• Quantum Nanostructures, Optics, and Applications
  ➢ A. Forchel, Wuerzburg University
  "Strongly Coupled Single Quantum Dot-Microcavity System"
  ➢ D. Awschalom, University of California, Santa Barbara
  "Optoelectronic Control of Electron and Nuclear Spins in Semiconductor Nanostructures"

• Cold Atoms, Cold Molecules, Collective Quantum Phenomena and Atom Optics
  ➢ Similar to C15

• New Trends in Chemistry, Biology and Other Fields
  ➢ D. Miller, Stanford University
    "Nanoresonators and Nanophotonics"
  ➢ S. Fainman, Univ. California, San Diego,
    "Ultra Short Surface Plasmon Polaritons in Photonic Crystal Structures"
Session Titles at IQEC 2005

• Photonic Nanostructures and Devices
  ➢ Y. H. Lee, KAIST
    "Photonic Crystal Nanolasers by Optical and Electrical Pump"
  ➢ M. Notomi, NTT Basic Research Laboratories,
    "Nonlinear Switching by Photonic-Crystal Nanocavities for All-Optical Digital Processing"

• Near-field Optics and Applications
  ➢ Y. Inoue, Graduate School of Frontier Biosciences
    "Tip-Enhanced Near-Field Raman Spectroscopy for Molecular Nano-Imaging"

• THz Emission and Spectroscopy
  ➢ T. Norris, Michigan University
    "Nanoacoustics: Propagation and Imaging with THz Coherent Phonons"
  ➢ S. Komiyama, University of Tokyo
    "Photon Counting THz Imaging with Quantum-Dot Detectors"
Session Titles at IQEC 2005

• Nonlinear Optics and Materials
  - H. Kamada, NTT Basic Research Laboratories
    "Coherent Nonlinear Effects in a Single Quantum Dot"

• Single Photon Emission and Entanglement States for Quantum Information
  - J. Vuckovic, Stanford University
    "Single Photon Source Based on a Quantum Dot in Photonic Crystal"

• Dynamics of Photoinduced Phase Transition
  - M. Rini, Lawrence Berkeley National Laboratory
    "On Photo-Induced Phase Transitions in Strongly Correlated Nanosystems"

• Plenary Speaker
  - Prof. Zhores Alferov
    Director, The Ioffe Institute, Russia
    2000 Nobel Laureate in Physics
    "Past, Present and Future of Semiconductor Lasers and Related Nanophotonic Devices"
Harvard
Prof. Charles Lieber’s Group

A transmission electron microscope (TEM) image of a Cadmium Sulfide nanowire.

Future directions:
Radial and segmented nanowire structures

A photoluminescence image of a Cadmium Sulfide nanowire.
Nanowire Devices

Schematics: nanowire photonic crystal with four engineered defects (left) nanowire racetrack microresonator (right).

Scanning electron microscope micrograph of the nanowire photonic crystal (left) and optical micrograph of the nanowire racetrack microresonator (right).

C. Lieber group
New materials for nanophotonics

III-nitride-based nanowire radial heterostructures as multicolor and high-efficiency light-emitting diodes.

C. Lieber group
New nanowire devices and structures


Epitaxially grown p-type GaN nanowire array.
Novel packages of nanodevices

Flexible plastic substrate containing arrays of nanowire devices. The devices do not degrade under the effect of bending.

C. Lieber group
Future nanophotonics

- Electrical injection lasers
- Single photon detectors
- Multi-color LED/laser arrays
- Photonic circuits & processors
- Silicon modulators is a hot topic

Integration of nanophotonics and silicon CMOS
Integrated all-optical pulse regenerator in chalcogenide waveguides

Nanophotonic photonic crystal

Ben Eggleton’s group
CUDOS
University of Sydney
Australia
Structure scaling

- Scanning electron micrographs
- Proportions maintained with reduction 50x
- Long wavelengths penetrate cladding – evanescent!

Microstructured optical fiber photonic wires with subwavelength core diameter

Yannick K. Lizé, Eric C. Mägi, Vahid G. Ta’eed, Jeremy A. Bolger, Paul Steinvurzel, and Benjamin J. Eggleton

Figure 5. Increased loss of a 3.5 μm outside diameter MDF photonic wire as a function of wavelength when index-matching fluid (n=1.515) covers the device. The solid curve shows the theoretical loss in this device due to radiation, while the dots show the experimental results.
Silica nanowires

Efficient Coupling to Chalcogenide Glass Photonic Crystal Waveguides via Silica Optical Fiber Nanowires

Christian Grillet¹, Cameron Smith¹, Darren Freeman⁴, Steve Madden⁴, Barry Luther-Davies⁵, Eric C. Magi¹, David J. Moss¹ and Benjamin J.Eggleton¹
Scalable Ion Trap Quantum Computer Vision

System Compatibility of Quantum & Classical: Spatial Pitch, Clock Speed, Operating Temperature, Power Dissipation
NJNC Fabricated Planar Trap

Trapped Fluorescing Cd ion
Nanocrystal Quantum Dots: Artificial Atoms
Single Quantum Dot Spectra

University of Wurzburg
Dr. Lukas Worschech
Fabrication of Nanocrystals

Bawendi Group – MIT
Banin Group – Hebrew Univ.

NQD Light Emission
Nanocrystals

**CdSe and CdTe** - Shell of ZnS
3-6 nm
visible

**PbSe** - No shell
8 nm
infrared (1.5 micron)

**InAs** - Shell of CdSe and ZnSe
7-8 nm
infrared (1.5 micron)
Nanocrystal Quantum Dots as Lasing Media

- Lower threshold than 3D and 2D lasers
- Wavelength (size) tunability
- Thermal gain stability
Summary

• Nanophotonics
  ➢ New lights sources
    ✓ Single photon sources
    ✓ Lab on chip sources (e.g. biophysics, cell studies)
  ➢ Nanowires
  ➢ Quantum dots
  ➢ Nanostructures fibers

• Quantum information
  ➢ Microfabrication of traps for ions, atoms and molecules
    ✓ Ions traps
    ✓ MEMS SLMs for atom traps
    ✓ Dipolar molecule traps
  ➢ Progress toward controlling many ions and atoms
    ✓ First studies of large controlled quantum assembles