euro PHOTONICS

December/January 2009

2009 EUROTECHNOLOGY TRENDS

STEREO DISPLAYS Not Just for Movies Anymore

3-D VISION Extending Robots' Reach

PHOTONICS) MEDIA | Worldwide Coverage: Optics, Lasers, Imaging, Fiber Optics, Electro-Optics, Photonics Component Manufacturing

Champion for Nanophotonics

AN INTERVIEW WITH CLIVIA M. SOTOMAYOR TORRES

BY KIMBERLEY CLARK, IRELAND CORRESPONDENT

Clivia M. Sotomayor Torres is the ICREA research professor at Catalan Institute of Nanotechnology in Barcelona. She also is coordinator of the EU Network of Excellence PhOREMOST, a consortium of scientific researchers from universities, research institutes and industry that is working to realize molecular-scale technologies.

Her accomplishments would fill this magazine – most likely twice. Her hallmark is the generation and promotion of new and futuristic technologies – most significantly, nanophotonics. Her journey to this point, a compelling story of determination and great talent.

Clivia M. Sotomayor Torres

"For me, the most exciting aspect is dealing with the concepts and methodologies that are at the forefront of nanophotonics."

You just completed four years as a research professor funded by Science Foundation Ireland at Tyndall National Institute, University College Cork. What was your focus?

I directed a research group working on photonic nanostructures. One of our projects involved demonstrating the use of nanoimprint lithography to fabricate 2-D polymer photonic crystals doped with quantum dots, an exercise that showed a record extraction efficiency.

The group also used nanoimprinting to fabricate bimetallic nanoelectrodes of importance for organic photovoltaics. In a separate development on self-assembly, they found that stochastic resonant processes play a key role in the self-assembly of highly ordered colloidal crystals, which will help in the volume production of 3-D photonic crystals, for example.

You've been extremely involved in PhOREMOST, a four-year European project boasting a network of almost 300 researchers that addresses the technologies of nanophotonics and molecular photonics. What is your role there?

I have worked on coordinating the efforts of 35 laboratories to establish nanophotonics in the European research area as both a fundamental science and an applied science. PhOREMOST concentrates its efforts in the areas of molecular photonics structures, novel functionalities at the nanoscale, nanophotonic devices and bridging the nano-micro gap. The group just released its road map for "Emerging Nanophotonics," combining its expertise and views on how the field is likely to develop during the next five to 15 years. It identifies scientific and technical challenges, points out roadblocks and suggests possible strategies to overcome them.

You spent 15 months as a political prisoner of Chile's military government under Pinochet in the mid-1970s. How did you end up leaving the country?

I was 19 years old and a second-year university student, but I didn't make it to school one day. Under torture, someone let my name slip, and I was picked up and imprisoned in the first women's political prisoner concentration camp. I was among the first wave of prisoners – university students and highly educated professional women, journalists, doctors and lawyers – who were victims of the repression that followed the military coup in Chile. Eventually, I was expelled from the country, and I was given five minutes to talk to my father before I boarded the plane for England.

> "I expect that scientists will use organic photovoltaics with nanoparticle-loaded polymers to build energy-harvesting devices ..."

The United Kingdom gave me political asylum, and I completed my physics degree at the University of Southampton.

When were you able to return to your homeland?
I spent a lot of time working with the International Red Cross, gathering names and fact-finding to help locate political prisoners. I was lucky to be alive. But I had to wait 14 years – until Pinochet left power – before I could return.

I would like to think there is no animosity, but I believe it will take a long time to heal the divisions.

What is the most exciting aspect of your work today? And the most challenging?
For me, the most exciting aspect is dealing with the concepts and methodologies that are at the forefront of nanophotonics – concepts arising from random and periodic optical materials, such as photonic crystals, and the fabrication of these nanostructures by means of self-assembly and electron beam lithography as well as nanoimprint lithography. The most challenging is the interaction between photons and acoustic waves; this research challenge has prompted my interest in the study of phonons in nanostructures.

What are the prospects of nanophotonics in the future?
I expect that scientists will use organic photovoltaics with nanoparticle-loaded polymers to build energy-harvesting devices such as solar cells and organic light-emitting devices.

Nanophotonics benefits from the development of new and better materials, allowing tailored light-matter interaction. Without the right materials, you cannot achieve the correct optical or photonic property or function, and, thus, you cannot progress to a device concept. I find the interactions between photons and plasmons and between photons and phonons fascinating. These interactions can have a profound impact in variable-length communications systems.

Ambient intelligence brings information into the living environment in a more integrated manner than a standard electronic device can. Where do nanophotonics fit in?
At the molecular scale, in the medium to long term, researchers are working on molecular memories, in which information can be stored and retrieved from a single molecule, and molecular arrays, which will provide greater miniaturization (a device worn on your wrist, perhaps) and greater flexibility (an electronic environment designed into wallpaper, for example).

The potential is limitless, but as with the commercialization of any technology, there needs to be a cost threshold where companies manufacturing these devices believe they can sell them and consumers feel they can afford them.

One of the most important contributions of nanophotonics is its ability to combine the length scales of light with those of electrons and phonons providing flexibility for hybrid optical systems based on the best optical properties nanostructured materials can offer.

Do you ever get frustrated in your work?
Yes, of course. A major frustration is the slow pace of European integration with regard to research.

If you were in charge, how would you fix it?
Simplify the regulations at the national level first so they become redundant at the EU level.

What would you most like to accomplish before your research is done?
That's a tough one to answer because, when it's my time to go, they will have to drag me out of the lab first.

Photonics-Relevant Projects

Nanoproduction
ULTRAMAGNETRON – Ultrafast all-optical magnetization reversal for magnetic recording and laser-controlled spintronics (4.17/3.15 million euros).

NANOCHARM – Multifunctional nanomaterials characterization exploiting ellipsometry and polarimetry (1.59/1.2 million euros).

Health
NANOPHOTO – Targeted nanosystems for improving photodynamic therapy and diagnosis of cancer (3.24/2.45 million euros).

FUN OCT – Functional optical coherence tomography (7.09/5.41 million euros).

CARS EXPLORER – Innovative contrast imaging by nonlinear optics (NLO) for the observation of biological tissues in vivo and in real time, at cellular and molecular levels (4.77/3.09 million euros).

Security
IDETECT 4ALL – Intruder detection and authentication optical sensing technology (3.24/2.3 million euros).

AMASS – Autonomous maritime surveillance system (4.97/3.58 million euros).

Energy
IBPOWER – Intermediate band materials and solar cells for photovoltaics with high efficiency and reduced cost (4.61/3.95 million euros).

ROBUST DSC – Efficient and robust dye-sensitized solar cells and modules (5.32/3.98 million euros).

HIGH EF – Large-grained, low-stress multicrystalline silicon thin-film solar cells on glass by a combined diode laser and solid-phase crystallization process (4.46/2.86 million euros).

HETSI – Heterojunction solar cells based on a-Si/c-Si (5.05/3.4 million euros).

Transport
DANIELA – Demonstration of anemometry instrument based on laser (6.43/4.14 million euros).

Information and Communication Technologies
WADIMOS – Wavelength division multiplexed photonic layer on CMOS (3.18/2.3 million euros).

AMAZOLED – Active matrix of any shape with organic LED displays (6.7/4.8 million euros).

PHORCE21 – Photonics research coordination Europe/Photonics21 (1.37/1.35 million euros).

GOSPEL – Governing the speed of light (3.33/2.19 million euros).

MINOS – Micro- and nano-optomechanical systems for ICT and QIPC (Quantum Information Processing and Communication) (3.13/2.27 million euros).

HIDEAS – High-dimensional entangled systems (for QIPC) (4.58/2.0 million euros).

PHASORS – Phase-sensitive amplifier systems and optical regenerators and their applications (3.91/2.7 million euros).

INTOPSENS – A highly integrated optical sensor for point-of-care label-free identification of pathogenic bacteria strains and their antibiotic resistance (3.36/2.6 million euros).

FLAME – Flexible organic active matrix organic LED displays for nomadic applications (3.93/3.0 million euros).

FAST2LIGHT – High-throughput, large-area, cost-effective organic LED production technologies (15.48/10.0 million euros).

PHOME – Photonic metamaterials (1.9/1.43 million euros).

MIRSURG – Mid-infrared solid-state laser systems for minimally invasive surgery (3.92/2.8 million euros).

MARISE – Materials for avalanche receiver for ultimate sensitivity (3.24/2.1 million euros).

MINIGAS – Miniaturized photoacoustic gas sensor based on patented interferometric readout and novel photonic integration technologies (2.77/1.85 million euros).

MUSIS – Multispectral terahertz, infrared, visible imaging and spectroscopy (4.64/3.2 million euros).

PYTHIA – Monolithically integrated interferometric biochips for label-free early detection of human diseases (3.48/2.65 million euros).

OPTHER – Optically driven terahertz amplifiers (4.1/2.45 million euros).

EURO-FOS – Pan-European photonics task force: integrating Europe's expertise on photonics subsystems (5.06/4.1 million euros).

MEMPIS – Ultrasmall MEMS FTIR spectrometer (4.43/2.85 million euros).

PHOTONFAB – Silicon photonic IC fabless access broker (973,000/745,000 euros).

GIGAWAM – Gigabit access passive optical network using wavelength division multiplexing (9.12/3.0 million euros).

HELIOS – Photonics electronics functional integration on CMOS (12.05/8.5 million euros).

BOOM – Terabit on chip: micro- and nanoscale silicon photonic integrated components and subsystems enabling terabit-per-second capacity, scalable and fully integrated photonic routers (4.24/3.1 million euros).

POF-PLUS – Plastic optical fibre for pervasive low-cost, ultrahigh-capacity systems (3.66/2.6 million euros).

PHOSFOS – Photonic skins for optical sensing (2.48/1.9 million euros).

DELIGHT – Development of low-cost technologies for the fabrication of high-performance telecommunication lasers (4.78/3.3 million euros).

APACHE – Agile photonic integrated systems on chip enabling WDM terabit networks (3.98/2.9 million euros).

SENSHY – Photonic sensing of hydrocarbons based on innovative mid-infrared lasers (3.19/2.35 million euros).

SUBTUNE – Widely tunable VCSEL using subwavelength gratings (3.74/2.75 million euros).

AEVIOM – Advanced experimentally validated integrated organic LED model for a breakthrough in high-performance organic LED technology (3.88/2.55 million euros).

HYPOLED – High-performance organic LED-microdisplays for mobile multimedia HMD and microprojection applications (4.13/3.05 million euros).

COMPAS – Computing with mesoscopic photonic and atomic states (2.09/1.55 million euros).

CHIMONO – Nano-optics for molecules on chips (3.34/2.52 million euros).

HELIUM3D – High-efficiency laser-based multiuser multimodal 3-D display (4.2/2.8 million euros).

FUTON – Fibre optic networks for distributed and extendable heterogeneous radio architectures (9.85/6.58 million euros).

MAXIMUS – Maximum fidelity interactive multiuser display systems (3.18/2.2 million euros).

OLED100.EU – Organic LED lighting in European dimensions (19.96/12.5 million euros).

Other
LASER-ARPES – Laser-based photoemission: revolutionizing the spectroscopy of correlated electrons (1.45/1.45 million euros).

Further information on any of these projects may be found at http://cordis.europa.eu/fp7/projects en.html – using the unique sounding project names. However, this is only the beginning. Do you have your own idea and want a piece of the pie? Further calls for new FP7 projects are being published; details may be found under cordis.europa.eu/fp7/dc/index.cfm. If you are more interested in what others do, however, we will keep you posted ...

Jörg Schwartz
j.schwartz@europhotonics.com