NEWSLETTER

COMMISSION INTERNATIONALE D'OPTIQUE · INTERNATIONAL COMMISSION FOR OPTICS

ICO Prize to Topological Photonics

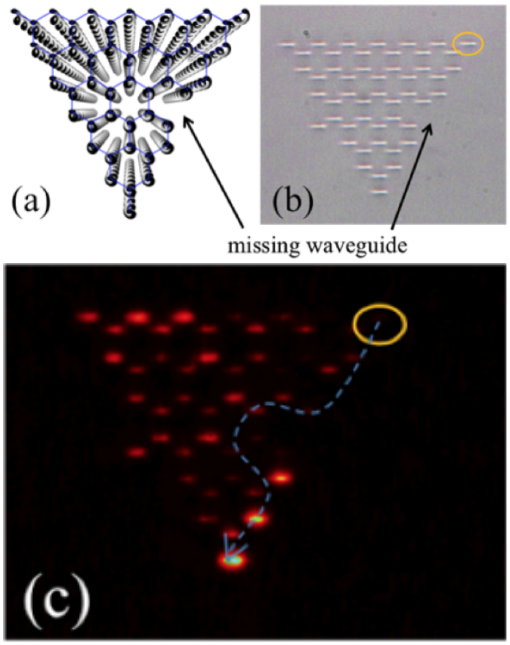
ICO Prize 2018 has been awarded to Mikael C. Rechtsman for his pioneering contributions to the field of topological photonics.

Mikael C. Rechtsman is Early Carrer Developmet Professor of Physics at the Pennsylvania State University (USA). The ICO Prize 2018 has been chaired by ICO Vice-Presidet, Prof. Dr. Seung-Han Park.

Mikael C. Rechtsman, the Downsbrough Early Career Development Professor of Physics at the Pennsylvania State University, has been awarded the 2018 ICO Prize for "pioneering contributions to the field of topological photonics." Prof. Rechtsman received his S.B. from the Massachusetts Institute of Technology and Ph.D. from Princeton University, and is a recipient of the Sloan Fellowship, the Packard Fellowship, and the Office of Naval Research Young Investigator award, among others. His group's theoretical and experimental research spans the fields of condensed matter physics, nonlinear optics, quantum optics, photonic crystals, aperiodic and disordered materials, soft matter physics, and topological photonics.

The work for which this prize was awarded[1] was the first realization of a "topological insulator for light," which was carried out in collaboration with Dr. Yonatan Plotnik and the groups of Prof. Mordechai Segev at Technion, Israel, and Prof. Alexander Szameit, currently at Rostock, Germany). Results showed that the incredible robustness of electron transport to disorder, as observed in the quantum Hall effect, could be carried over to photons propagating in complex photonic structures. This opened the door to the field of "topological photonics", i.e., using the ideas of topological physics as tools to engineer new and disorder-immune photonic materials and devices.

Rechtsman has continued his work on optics in complex structures, and in particular topological photonics, and his group is a leader of the field. His group has recently demonstrated the first realization of Weyl points in optics[2], the first realization of the valley Hall effect[3], as well as a "higher-order topological insulator"[4], a demonstration of four-dimensional quantum Hall physics via dimensional reduction[5] (simultaneously with the group of Immanuel Bloch[6]), and the first Weyl exceptional ring[7], among others. At the heart of these experiments lies the goal of pursuing new physics which uses photonics to go beyond what can be observed for electrons in the solid state - and which can be useful in fundamentally new photonic technology.



(a) Schematic diagram of "topological insulator for light." (b) Microscope image of the input facet of the array. (c) Chiral edge states injected at the top-right corner of the array propagate downward along the edge, propagate through a defect and do not backscatter.

[1] Rechtsman, M. C. et al. Photonic Floquet topological insulators. Nature 496, 196–200 (2013).
[2] Noh, J. et al. Experimental observation of optical Weyl points and Fermi arc-like surface states. Nat. Phys.13, 611–617 (2017).
[3] Noh, J., Huang, S., Chen, K. P. & Rechtsman, M. C. Observation of Photonic Topological Valley Hall Edge States. Phys. Rev. Lett. 120, 063902 (2018).
[4] Noh, J. et al. Topological protection of photonic mid-gap defect modes. Nat. Photonics 12, 408–415 (2018).
[5] Zilberberg, O. et al. Photonic topological boundary pumping as a probe of 4D quantum Hall physics. Nature 553, 59–62 (2018).
[6] Lohse, M., Schweizer, C., Price, H. M., Zilberberg, O. & Bloch, I. Exploring 4D quantum Hall physics with a 2D topological charge pump. Nature 553, 55–58 (2018).
[7] Cerjan, A., Huang, S., Chen, K. P., Chong, Y. & Rechtsman, M. C. Experimental realization of a Weyl exceptional ring. ArXiv:180809541 (2018).

Prof. Dr. Seung-Han Park
Chaired ICO Prize 2018

IUPAP Young Scientists Prize in Optics 2018

Prof. Can Bayram was awarded the 2018 IUPAP Young Scientist Prize in Optics *"for revolutionizing the way graphene has been employed and making major contributions to III-V photonic devices."*

Prof. Can Bayram is an Assistant Professor in the Department of Electrical and Computer Engineering of University of Illinois at Urbana-Champaign, IL, USA. Prof. Adrian Podoleanu chaired 2018 IUPAP Young Scientist Prize in Optics.

For the first time, Prof. Can Bayram has integrated GaN-based devices on CMOS-compatible silicon substrates. This work was highlighted as the frontispiece in the Advanced Functional Materials issue. Most notable, Prof. Bayram demonstrated direct epitaxy of GaN on Graphene for the first time, as published in Nature Communications, and revolutionized the way graphene has been employed in optics and photonics.

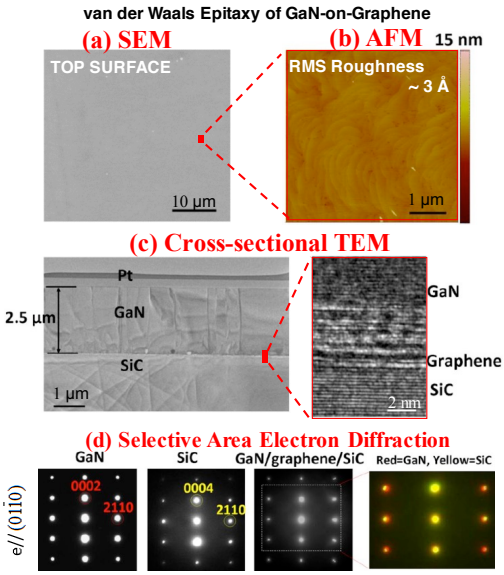
Despite having many superior electrical properties, graphene has not had a significant impact in electronics yet due to the absence of a band gap. Instead of focusing on electrical properties, Prof. Bayram exploited another unique property of graphene; graphene is crystalline and it does not form strong bonds with other materials.

This thought process led him to develop the technique for growing high cost semiconductors on graphene. In this aspect, in Nat. Comm. 5: 4836 (2014) four major breakthroughs are reported as:

(1) Large scale epitaxial growth of "single crystalline" GaN on graphene (one [0001] orientation).
(2) Exfoliation of entire single crystalline GaN film from the graphene template and dry-transfer onto a Si substrate.
(3) Multiple growth/transfer of GaN by the reuse of a single graphene template.
(4) Fully-functional single crystalline and flexible III-nitride blue LEDs on plastic.

This work is of wide interest for the scientific community and even in the general public sector because the results show a new paradigm for graphene-based technology. Also, immediate impact on the scientific society is expected since the concept of semiconductor growth and transfer by using a graphene template could be generally applied for many other 3D and 2D materials.

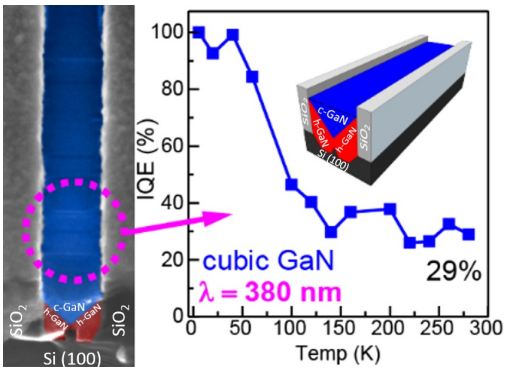
Prof. Bayram also invented novel ZnO-InGaN hybrid green LED [Appl. Phys. Lett. 93, 081111 (2008)], held the world record output power for ultraviolet LEDs on silicon platform [Appl. Phys. Lett 102, 011106 (2013)], and contributed to the development of thin-film inorganic vertical LEDs suitable for bioimaging, biomanupulation, and biophotonics [Appl. Phys. Express 6 (11), 112301 (2013)].



3D-on-2D technology as exemplified by GaN-on-Graphene. High quality GaN layers are grown on epitaxial graphene. (a) Scanning electron and (b) atomic force microscopy images reveal atomically smooth surfaces. (c) Cross-sectional transmission electron microscopy and (d) selective area electron diffraction reveal crystallographic arrangement between the layers. [adopted from Nat. Comm. 5: 4836 (2014)].

However, no one has imagined that the III-nitride spectrum could be expanded into infrared and even terahertz as conventional band-to-band energy gap did NOT allow. In his early career, Prof. Bayram pushed the wavelengths of GaN technology to longer and longer wavelengths above visible by engineering INTERSUBBAND energy levels, to reach terahertz spectrum.

In this area, he has demonstrated a couple of breakthroughs: (1) First GaN devices (by MOCVD) at the optical telecommunications wavelengths (~1.5 μm) [Appl. Phys. Lett. 95, 201906 (2009)], (2) Longest optical transitions in GaN materials (up-to 5.5 μm) [J. Appl. Phys. 111, 013514 (2012)], and (3) First reliable resonant tunneling in GaN.



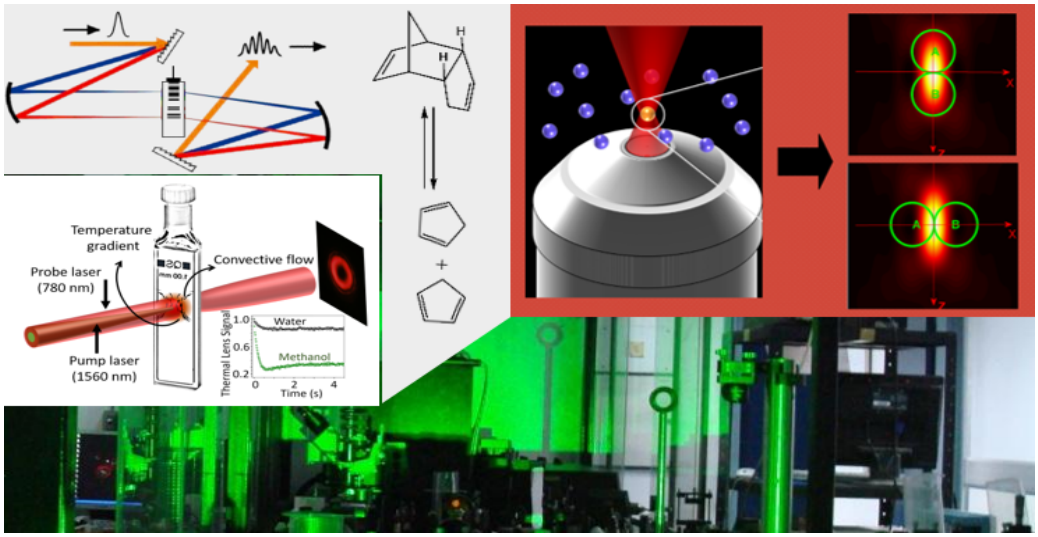
This figure demonstrates the process of phase transition of hexagonal GaN (red) to cubic GaN (blue) through the composite SEM image of these U-shaped grooves [adopted from ACS Photonics 5(3), 955 – 963 (2018)].

IUPAP Prize 2018 was chaired by ICO VP Prof. Adrian Podoleanu

D. Goswami receives the ICO Galileo Galilei Medal

Prof. Debabrata Goswami of the Indian Institute of Technology Kanpur has been awarded the 2018 ICO Galileo Galilei Medal

Prof. Goswami holds the Prof. S. Sampath Chair Professor of Chemistry of the Indian Institute of Technology, Kanpur (IITK). He is also Adjunct Professor at the Center for Lasers and Photonics, the Design Program and the Center for Cognitive Science.



Sketch of optical systems developed at Goswami`s lab: pulse shaping, thermal lens and optical tweezers

Prof. Goswami is an ultrafast laser spectroscopist who has pioneered the use of coherent control with femtosecond pulse shaping for spatiotemporal control, quantum computing, microscopy, etc. His research work includes the construction of several tunable and programmable femtosecond pulse shapers to deal with measurement uncertainty. His methods to circumvent the intricacies of ultrashort time scales involve utilizing Fourier optics and interferometers.

He has been the first to propose that the dissipation dynamics of thermal lens introduced by high repetition rate femtosecond lasers include convective processes. His work is rooted in insightful experiments and has shown the thermal lens dissipation results in molecular structure distinction. He has developed self-calibrated femtosecond optical tweezers (SCFOT) that can directly probe colloidal assembly, their structure, and orientation.

He used this novel method of SCFOT to directly measure and control 'in situ' temperature and viscosity at microscale volumes. Visualizing the hitherto unseen being a common thread of his research efforts, he pioneered a method to distinguish between overlapping fluorophores in multi-photon imaging microscopy by exploiting repeated excitation and de-excitation processes with high repetitive rate femtosecond lasers.

Some of the academic and research accolades of Dr. Goswami are the Hoechst Advanced Technology Division Industrial Affiliates Fellowship for outstanding academic record at Princeton, the International Senior Research Fellowship award of the Wellcome Trust (UK), the Swarnajayanti Fellowship of the Department of Science and Technology (Govt. of India), Thathachary Science Award (India).

Prof. Goswami is notable also for his passion for pedagogy and is a passionate and engaging teacher, who is also a favorite K12 teacher on Indian Television. His courses in IITK are always in high demand amongst undergraduates, and he volunteered a 12-week graduate level course on Quantum Computing for the National Portal for Technology Education and Learning. His passion for research is not localized to himself, however, as he has guided fifteen Ph.D. scholars, sixty-four Masters Students, and countless undergraduate students. Many of his students are now formidable researchers in their own right. He is known for maintaining a balance between being a driven supervisor and a caring guardian. His unwavering dedication to the pursuit of excellence in research, regarding the ethics and the expansion of human knowledge, has inspired and equipped his students to develop their ideas and to explore new directions. Prof. Goswami has maintained and built several of his femtosecond lasers himself, in times of erratic financial funding. He continues to work on the intricacies of measurement, light-matter interactions, and practical applications of theoretical knowledge, ever ready to guide students or learn side by side with them.

Prof. Nataliya Kundikova
Chaired the committee for the ICO Galileo Galilei Medal 2018

TeraWatt Laser "STELA" led by a woman in Spain

Prof. Maite Flores (center) from the University of Santiago de Compostela, is the first woman in Spain leading this type of facility.

Last October 2018, the University of Santiago de Compostela (USC) took the first steps to open to the entire scientific and industrial sector, a new facility called Laser Acceleration Laboratory and other applications (L2A2) with the appointment of Prof. Maite Flores-Arias as coordinator of the installation. She is the first woman in Spain leading this type of facility.

The laser "STELA" (Santiago TErawatt LAser) is based on Titanium:Sapphire technology with the ability to produce beam lines in a dual CPA (Chirped Pulse Amplification) configuration and a maximum intensity of 45TW.

One of the lines provides a laser pulse with a temporal duration of 35 femtoseconds, 1 mJ per pulse, a contrast below 10^{-7} and a repetition rate of 1 Khz. This beam line can produce Xrays and high-order harmonics, among other exciting effects. In addition to the low energy, the STELA laser provides a high intensity pulse with a temporal duration of 25 femtoseconds, 1.2 joules per pulse, contrast of 10^{-10} and a repetition rate of 10 Hz.

This high energy pulse propagates to an experimental vacuum chamber, where the acceleration of particles can take place in order to carry our plasma studies, among other experiments.

With this new installation, the University of Santiago de Compostela is committed to the future of photonics, as well as being a new center of attention for those interested in femtosecond applications, including low or high intensity laser pulses.

Contacts

International Commission for Optics (http://e-ico.org).

Forthcoming events with ICO participation

Below is a list of 2019 events with ICO participation. For further information, visit the new ICO web at http://e-ico.org/node/103.

11–22 February 2019
Winter College on Applications of Optics and Photonics in food Science
ICTP, Trieste, Italy
Contact: Joe Niemela
tel: +39 0402240607
niemela@iftp.it
Indico.ictp.it/event/8643/

21–24 May 2019
ETOP2019: Education and training in Optics and Photonics
Quebec City, Canada
Contact: Pierre Bolduc
tel: +418 5228182
Pierre.bolduc@conferium.com
etop2019.copl.ulaval.ca

23–27 September 2019
RIAO-OPTILAS-MOPM 2019
Iberoamerican optics meeting
Cancún, Mexico
Contact: Josué Álvarez-Borrego
tel: +646 175 0500
riao2019@cio.mx
www.riao.org.mx/optilas_2019/

31 May–4 June 2019
4th International Conference on Applications of Optics and Photonics
Lisbon, Portugal
Contact: Manuel Costa
tel: + 351 253 604 070
aop2019@optica.pt
www.aop2019.org

4–7 September 2019
Optisud: ICO-IUPAP-C17 Meeting on Optics & Applications to Sustainable Development
Carthage, Tunisia
Contact: Prof. Mourad Zghal
tel: +216 20202020
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Responsibility for the correctness of the information on this page rests with the International Commission for Optics (ICO); http://www.e-ico.org/. *President:* Prof. Roberta Ramponi, Director IFN-CNR, Politecnico di Milano, Italy; roberta.ramponi@polimi.it. *Treasurer:* Prof. Joseph Niemela, International Center for Theoretical Physics, Italy; niemela@ictp.it. *Secretary*: Prof. Humberto Michinel, Universidade de Vigo, Spain; hmichinel@uvigo.es. *Associate Secretary:* Dr. Frank Höller, Carl Zeiss AG, Germany; frank.hoeller@zeiss.com