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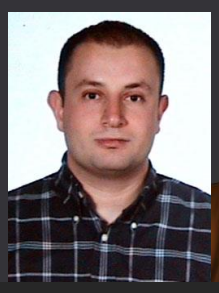

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"Nanocrystal Optoelectronics: from Solution-Processed Quantum Dots to Wells"

Wednesday,
13 December, 2017

12:00 refreshments
12:30 lecture

Solid State Auditorium
Entrance Floor

RBNI Monthly Seminar Series 2017

TECHNION
Israel Institute
of Technology

Nanocrystal Optoelectronics: from Solution-Processed Quantum Dots to Wells

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Colloidal semiconductor nanocrystals have been attracting increasingly greater interest in photonics including color conversion and enrichment in quality lighting and display backlighting [1]. Optical properties of these nanocrystals can be conveniently tuned by controlling their underlying excitonic mechanisms [2]. Their rational design and excitonic control provide us with the ability to make highly efficient light-emitting diodes [3] and optically-pumped lasers [4]. In this talk, we will introduce the emerging field of nanocrystal optoelectronics using solution-processed quantum dots to wells. In particular, we will present a new concept of all-colloidal lasers developed by incorporating nanocrystal emitters as the optical gain media intimately into fully colloidal cavities [5]. As an extreme case of solution-processed tightly-confined quasi-2D quantum structures, we will also show that atomically flat nanocrystals, analog of epitaxial thin-film quantum wells, allow for record high optical gain and ultralow lasing threshold among all colloids. In addition, we will discuss that controlled stacking of these colloidal quantum wells uniquely enables us to fine-tune and master their excitonic properties [6]. We will also show that doping such nanoplatelets leads to extraordinarily large Stokes shift, accompanied with near-unity quantum efficiency and high absorption cross-section, ideal for luminescent solar concentrators [7]. Furthermore, advanced heterostructures of these nanoplatelets make it possible to target other applications such as remote temperature sensing [8]. Given the recent accelerating progress in nanocrystal optoelectronics, solution-processed quantum materials hold great promise to challenge their conventional epitaxial counterparts.

[1] HVD et al., *Nano Today* 6, 632 (2011)
[2] BGuzelturk et al. HVD, *Laser & Photonics Reviews* 8, 73 (2014); *J. Phys. Chem. Lett.* 5, 2214 (2014); *Advanced Functional Materials* 26, 8158 (2016) ; TErdem and HVD, *Nature Photonics*, 5 (3), 126, (2011)
[3] XYang et al. XWSun and HVD, *Advanced Functional Materials* 24, 5977 (2014); *ACS Nano* 8, 8224 (2014) and *Advanced Materials* 24, 4180 (2012)
[4] YWang et al. HVD and HSun, *Advanced Materials* 27, 169 (2015) and *Nano Letters* 17, 2640 (2017) and YGao et al. HSun and HVD, *J Phys. Chem. Lett.* 7, 2772 (2016)
[5] BGuzelturk et al. HVD, *Advanced Materials* 27, 2741 (2015)
[6] BGuzelturk et al. HVD *ACS Nano* 8, 6599 (2014) and *ACS Nano* 8, 12524 (2014); M. Olutas et al. HVD, *Advanced Functional Materials* 26, 2891 (2016) and O. Erdem, et al. HVD *J Phys. Chem. Lett.* 7, 548 (2016)
[7] MSharma et al. HVD *Advanced Materials,* 29, 1700821 (2017)
[8] YKelestemur et al. HVD, *Advanced Functional Materials* 26, 3570 (2016) and *Chemistry of Materials*, 29, 4857 (2017)

Short biosketch: Dr. Hilmi Volkan Demir is a professor of physics and electrical engineering at NTU Singapore and serves as the Director of LUMINOUS! Center of Excellence for Semiconductor Lighting and Displays and an NRF Fellow of Singapore. Concurrently, he holds a chair professorship in materials science and nanotechnology at Bilkent University and UNAM – The National Nanotechnology Research Center at Bilkent (his alma mater). Demir earned his PhD (2004) and MSc (2000) degrees from Stanford University, CA, and his BSc degree (1998) from Bilkent University. His current research interests include the science and technology of semiconductor lighting; nanocrystal optoelectronics; excitonics and plasmonics for high-efficiency light generation and harvesting; and wireless sensing and smart implants. Demir published over 300 peer-reviewed research articles in major scientific journals and delivered over 200 invited seminars, lectures and colloquia on the topics of LED lighting, colloidal nanophotonics, in vivo sensing, and nanoparticles research in industry and academia. Demir has contributed to commercialization and licensing of several new enabling technologies, leading to >30 patent applications (granted and pending) as the principle inventor, several of which have currently been used, owned or licensed by the industry. His research work has led and contributed to four successful spinoffs. These scientific and entrepreneurship activities resulted in several important international and national awards including NRF Investigatorship Award, Nanyang Award for Research Excellence, The Rank Prize Scholar, and European Science Foundation EURYI awards. Presently, he is the SPRINGER Series Editor of Nanoscience and Nanotechnology and an editor of Optics Express, a leading open-access journal of OSA. Dr. Demir is the Guest Editor in IEEE Proceedings (2018) on active nanophotonics, IEEE Selected Topics in Quantum Electronics (2017) on nanocrystal optoelectronics, and Optics Express (2016) on colloidal photonics issues. Professor Demir served as the 2017 General Chair, 2016 Member-at-Large and 2015 Technical Chair of IEEE IPC, IEEE Photonics Society flagship annual meeting.