NUS National University of Singapore

Department of **Materials Science & Engineering** seminar

Nanocrystal Optoelectronics: from Colloidal Quantum Dots to Wells

by Prof Hilmi Volkan Demir

Date: 24 October 2019 (Thursday)

Time: 2.00pm – 3.00pm

Venue: EA-06-05

Abstract

Solution-processed semiconductor nanocrystals have been attracting increasingly greater interest in photonics including spectrally pure color conversion and enrichment in quality lighting and display backlighting [1,2]. These nanocrystals span different types and structures of semiconductors in the forms of colloidal quantum dots and rods to a more recently developing class of colloidal quantum wells. In this talk, we will introduce the emergent field of nanocrystal optoelectronics using solution-processed quantum dots and wells. In particular, we will present a new concept of all-colloidal lasers developed by incorporating nanocrystal emitters as the optical gain media, intimately integrated into fully colloidal cavities [3]. In the talk, we will then focus on our recent work on the latest rising star of tightly-confined atomically flat nanocrystals, the quasi-2D colloidal quantum wells (CQWs), also popularly nick-named 'nanoplatelets'. Among various extraordinary features of these CQWs, we will present our most recent discovery that the CQWs uniquely enable record high optical gain coefficients among all colloids [4]. In addition, we will show the controlled stacking and assemblies of these nanoplatelets, which provides us with the ability to tune and master their excitonic properties [5], and present the first accounts of doping them for high-flux solar concentration and precise wavefunction-engineered magnetic properties [6]. Given their current accelerating progress, these solution-processed quantum materials hold great promise to challenge their epitaxial thin-film counterparts in semiconductor optoelectronics in the near future.

Speaker

Hilmi Volkan Demir graduated from electrical and electronics engineering at Bilkent University, one of the top engineering schools in Turkey, with a B.Sc. degree in 1998, following which he received M.Sc. degree (Edward L Ginzton Fellowship) in 2000 and then Ph.D. degree (Intel-Stanford Fellowship) in 2004, both in electrical engineering from Stanford University, CA. Currently, as an NRF Fellow of Singapore, he is a professor of electrical engineering, physics and materials science at NTU Singapore and serves as the Director of LUMINOUS! Center of Excellence for Semiconductor Lighting and Displays. Concurrently, he holds an appointment at his alma mater, Bilkent University UNAM. His current research interests include semiconductor nanocrystal optoelectronics; the science and technology of semiconductor lighting; and excitonics/plasmonics for high-efficiency light generation and harvesting. Dr. 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 colloidal nanophotonics and LED lighting in industry and academia. Dr. Demir has contributed to commercialization and licensing of several new enabling technologies as well as establishing several successful companies and has generated >40 patent applications as a principal inventor, some of which have currently been used, owned or licensed by the industry. These scientific and entrepreneurship activities resulted in important international and national awards including NRF Investigatorship Award, Nanyang Award for Research Excellence, European Science Foundation EURYI Award, TUBITAK TESVIK Award, and TUBA-GEBIP Distinguished Young Scientist Award. He has been selected The Outstanding Young Person in the World (TOYP Award) of Junior Chamber International (JCI) Federation of Young Leaders and Entrepreneurs Worldwide in the category of academic achievement and leadership. He is currently the Springer-Nature Series Editor of Nanoscience and Nanotechnology and an editor of Optics Express. He served as the Technical Chair (2015), Member-at-Large (2016), and General Chair (2017) of the IEEE Photonics Society's flagship program IEEE Photonics Conference (IPC). He is an elected Fellow of Optical Society of America (OSA) and an elected Associate Member of the Turkish National Academy of Sciences -- TUBA.

ALL ARE WELCOME!

Host: Prof Silvija Gradecak-Garaj