Session 38: Optoelectronics, Displays, and Imagers - Displays, TFTs, and Optical Synapses
Wednesday, December 5, 1:30 PM
Continental Ballroom 5
Co-Chairs: B. Peterson, University of Michigan
L. Zhou, BOE Technology Group., Ltd.

1:35 PM - 2:00 PM
38.1 Fully Multi-Functional GaN-based Micro-LEDs for 2500 PPI Micro-displays, Temperature Sensing, Light Energy Harvesting, and Light Detection, *Z. Liu, K. Zhang, Y. Liu, S. Yan, H. S. Kwok, J. Deen, and X. Sun, Southern University of Science and Technology*

GaN-based Micro-LEDs were developed for more than a decade and are considered as the next generation of display technology. Micro-LEDs have more versatile functions than displays. We report fully multi-functional Micro-LEDs for micro-displays, temperature sensing, light energy harvesting, and light detection. The 2500 pixel per inch (PPI) Micro-LED devices displayed animations and pictures in display mode driven by a Si complementary metal-oxide-semiconductor (CMOS) backplane. In temperature sensing mode, it showed a sufficient linearity with a resolution of 795 K/V. It also had a fill factor of 65.9% and efficiency of 15.5% in light energy harvesting mode and a sensitivity of 1240 and external quantum efficiency (EQE) of 33% in light detection mode. Results real that the proposed devices can be used as a self-sustainable micro-system for low cost and eco-friendly applications.

2:00 PM - 2:25 PM
38.2 Environmentally Friendly Quantum Dots for Display Applications (Invited), *E. Jang, SAIT, Samsung Electronics*

Ever since the physics of quantum dot (QD) was discovered, much research effort has been carried out for more than 30 years, and lots of applications adopting QDs have been proposed. Especially, wide color gamut displays using QDs as active light emitting materials have drawn much attention. And, the QD-based consumer displays such as LED TVs, tablets, and special monitors are now on the market. They provide best color gamut, reasonable power efficiency, and affordable price showing superior competitive edge to OLED technology. However, still there are issues and argues using Cadmium containing materials in practical consumer devices. In spite of the European RoHS Exemptions, we need to be aware the environmental risk of producing large quantity of Cd-containing materials and using them in the consumer electronics. And, this growing apprehension for environmental issues formed great limitation for QD's applications. Therefore, we have dedicated to develop more environmentally friendly InP based QDs that showed considerably high efficiency and saturated color spectrum compared to the Cd-containing materials. The structure of Cd-free QD was specially tailored for display applications and the synthetic process was optimized to produce reliable materials in commercial scales. In order to improve the efficiency and stability of the QDs in the devices operating under severe atmosphere, specific composite materials were designed and the fabrication process was optimized. From 2015, Samsung has released Cd-free QD adopted UHD TV for major product line-up which show the best color gamut among the current displays. Now we are trying to make additional breakthroughs in displays by using established QD material platform and broaden the technology to wider optoelectronic applications.

2:25 PM - 2:50 PM
38.3 Solution Processed High Performance Short Channel Organic Thin-Film Transistors with Excellent Uniformity and Ultra-low Contact Resistance for Logic and Display, *L. Feng, Y. Huang*, J. Fan*, J. Zhao*, S. Pandya**, S. Chen8, W. Tang*, S. Ogier, and X. Guo*, Wuhan Xinqu Chuangrou Optoelectronics Technology Co., Ltd, *Shanghai Jiao Tong University, **NeuDrive Limited*

High performance organic thin-film transistors (OTFTs) are fabricated by using normal spin-coating processes with the highest processing temperature of 115 ºC. The devices present negligible contact resistance and excellent uniformity over 4 inch area. An average mobility higher than 4 cm2/V.s is achieved with 7 μm channel length devices. Ring oscillators and AMOLED displays based on the OTFTs are demonstrated. A dual gate structure is implemented to tune the threshold voltage of the OTFTs for improving the compensation and gray-level adjusting capability of an AMOLED in-pixel compensation circuit.

2:50 PM - 3:15 PM

38.4 Record Static and Dynamic Performance of Flexible Organic Thin-Film Transistors, *J. W. Borchert, U. Zschieschang, F. Letzkus**, M. Giorgio***, M. Caironi***, J. N. Burghartz**, S. Ludwigs* and H. Klauk, Max Planck Institute for Solid State Research, *Functional Polymers, Institute of Polymer Chemistry, Universität Stuttgart, **Institut für Mikroelektronik Stuttgart (IMS CHIPS), ***Center for Nano Science and Technology @PoliMi, Instituto Italiano di Tecnologia (IIT)*

Organic transistors with record static and dynamic performance on flexible substrates are presented. They operate with 3 V and have channel lengths down to 0.6 μm, on/off ratios of 1E10, subthreshold slopes of 59 mV/decade and ring-oscillator delays of 79 ns. These results are enabled by a record-low contact resistance.

3:15 PM - 3:40 PM

38.5 Hybrid Structure of Silicon Nanocrystals and 2D WSe_2 for Broadband Optoelectronic Synaptic Devices, *Z. Ni, Y. Wang, L. Liu, S. Zhao, Y. Xu, X. Pi, and D. Yang, Zhejiang University*

Optoelectronic synaptic devices based on the hybrid structure of silicon nanocrystals (Si NCs) and 2D WSe2 are fabricated. The Si-NC/WSe2 synaptic devices can be optically stimulated in a broad spectral region from the ultraviolet to near-infrared. The energy consumption of the devices may be as low as ~75 fJ.

3:40 PM - 4:05 PM

38.6 High Performance 2D Perovskite/Graphene Optical Synapses as Artificial Eyes, *H. Tian, X. Wang, F. Wu, Y. Yang, T.-L. Ren, Tsinghua University*

Conventional von Neumann architectures feature large power consumptions due to memory wall. Partial distributed architecture using synapses and neurons can reduce the power. However, there is still data bus between image sensor and synapses/neurons, which indicates plenty room to further lower the power consumptions. Here, a novel concept of all distributed architecture using optical synapse has been proposed. An ultrasensitive artificial optical synapse based on a graphene/2D perovskite heterostructure shows very high photo-responsivity up to 730 A/W and high stability up to 74 days. Moreover, our optical synapses has unique reconfigurable light-evoked excitatory/inhibitory functions, which is the key to enable image recognition. The demonstration of an optical synapse array for direct pattern recognition shows an accuracy as high as 80%. Our results shed light on new types of neuromorphic vision applications, such as artificial eyes.