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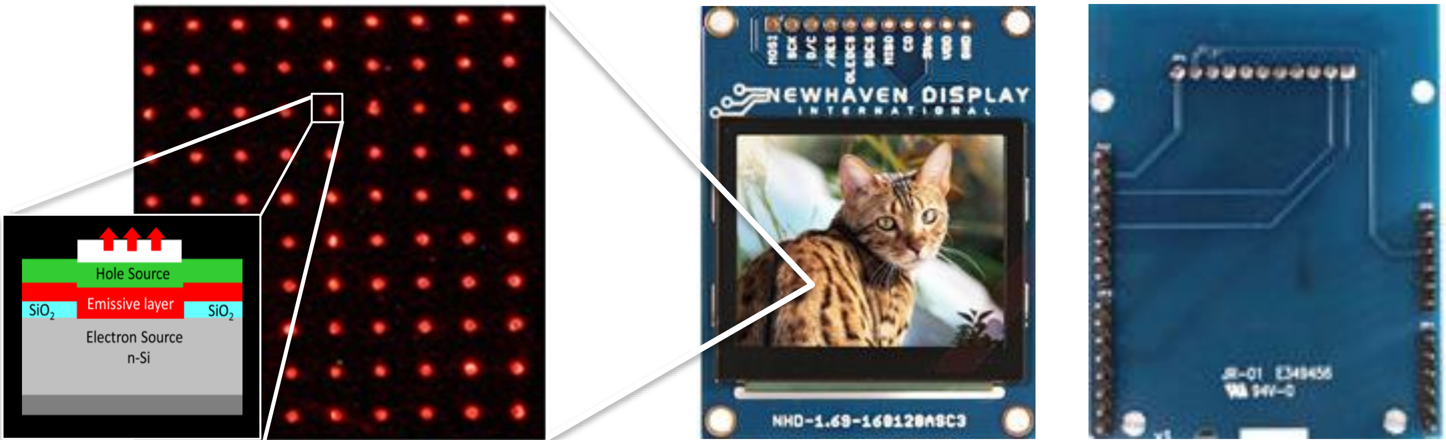

Nano-Eclipse

ID: 2704, 4097

Featured Innovators: Hong Koo Kim, PhD and Daud Hasan Emon

High-resolution and high-efficiency microdisplays are critical components of wearable electronics – such as smart glasses – but developing a low-power, high-brightness pixel technology has proven difficult. A liquid-crystal on silicon (LCoS) display, for example, requires an external light source that constantly draws significant current, whereas a micro-organic-light-emitting-diode (μ-OLED) display offers better power efficiency, but its brightness and lifetime are low. The Nano-Eclipse LED (N-LED) is expected to draw significantly less power than current microdisplays – potentially doubling battery life – while also offering higher brightness, contrast, and resolution. N-LEDs also have a low material cost compared to traditional LEDs, and they can be scaled down to the nanometer range.

Technology Description

The N-LED consists of five layers: a silicon-based electron supply layer, a quantum-dot emissive layer, a polymer hole layer, and an anode layer. When voltage is applied to the supply layer, a dense electron gas is formed at the junction with the next layer. The electrons repel each other and are injected strongly to the next layer above. The turn-on voltage required to achieve bright illumination is very low (~1-2V), and because illumination is greatest at the periphery of each emitter, efficiency improves as size shrinks, making this system ultimately scalable. Nanometer-sized perforations can be achieved right now using electron beam lithography, and ultimately we expect to generate sub-nanometer LEDs containing a single quantum dot. This technology can be used as a silicon-based single-photon source on demand, which will be important for future quantum information technology.

Advantages

- Lower power consumption than current microdisplay technology
- Low material cost
- High brightness, color contrast, and resolution
- Long lifespan
- Scalable to nanometer range
- Integrable to electronic chips

Applications

- Near-eye displays (e.g., camera viewfinders, head-mounted displays, and smart glasses)
- Quantum computing

Stage of Development

We have demonstrated light emission and confirmed low voltage operation. Currently, we are optimizing hole-spacing and the charge-conducting layer to achieve theoretical efficiency.

IP Status

- US patent 9,331,189 issued May 2016
- Divisional patent application 15/067,272 filed March 2016
- Provisional US patent application filed May 2017

Notable Mentions

- The Chancellor’s Innovation Commercialization Funds ($35,000)
- Pitt Ventures First Gear ($3,000)

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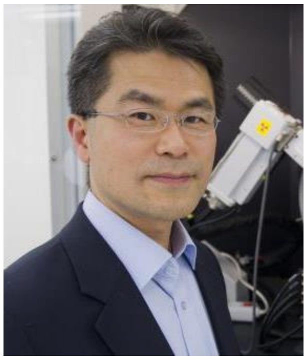

Hong Koo Kim, PhD

Bell Atlantic Professor
Electrical and Computer Engineering
University of Pittsburgh

Dr. Kim has over 30 years of experience in optoelectronics, nanoelectronics, and nano-optics/plasmonics research. He served as a founding co-director of the Petersen Institute of NanoScience and Engineering and has spun off two startup companies. Dr. Kim has won the Pitt Innovator Award four times.

Education

PhD in Electrical and Computer Engineering
Carnegie Mellon University

MS in Electrical Engineering
Korean Advanced Institute of Science and Technology

BS in Electronic Engineering
Seoul National University

Publications

- Kim M, Kim HK. Ultraviolet-enhanced photodetection in a graphene/SiO2/Si capacitor structure with a vacuum channel. Journal of Applied Physics. 2015 Sep 14;118(10):104504.
- Kim HK, Hanson GW, Geller DA. Are gold clusters in RF fields hot or not?. Science. 2013 Apr 26;340(6131):441-2.
- Srisonphan S, Jung YS, Kim HK. Metal-oxide-semiconductor field-effect transistor with a vacuum channel. Nature nanotechnology. 2012 Aug 1;7(8):504-8.
- Biswas M, Jung YS, Kim HK, Kumar K, Hughes GJ, Newcomb S, Henry MO, McGlynn E. Microscopic origins of the surface exciton photoluminescence peak in ZnO nanostructures. Physical Review B. 2011 Jun 13;83(23):235320.

Daud Hasan Emon

PhD student
University of Pittsburgh

Mr. Emon is a fourth-year PhD student working on optoelectronic devices incorporating emerging 2D materials, organic polymers and semiconductors to develop an economically viable and efficient lighting technology with record high resolution and efficiency. Previous experience in Samsung R&D institute as a research engineer providing technical support for FM radio and video telephone applications in Samsung Android devices.

Education

BS in Electronics
Bangladesh University of Engineering and Technology

Publications

- Emon DH, Kim M, Sharbati MT, Kim HK. Injection of 2D electron gas into a quantum-dot organic light-emitting diode structure on silicon substrate. Journal of Vacuum Science & Technology B, Nanotechnology and Microelectronics: Materials, Processing, Measurement, and Phenomena. 2016 Nov;34(6):06KJ01.
- Emon DH, Mohammad N, Mominuzzaman SM. Design of a low standby power CNFET based SRAM cell. In: Electrical & Computer Engineering (ICECE), 2012 7th International Conference on 2012 Dec 20 (pp. 213-216). IEEE.

University of Pittsburgh
Innovation Institute

130 Thackeray Ave
Pittsburgh, PA 15260

innovation.pitt.edu

Contact

George Coulston, PhD MBA
Technology Licensing Manager
412-648-2236
gcoulston@innovation.pitt.edu