SNU BK21 FOUR Education and Research Program for Future ICT Pioneers

서울대학교 BK21 FOUR 정보기술 미래인재 교육연구단

GoGE/SDG Workshop 2023

Group of Global Excellence (GoGE) / Sustainability Development Goal (SDG)

- ▶ **Topics : Optics and photonics, opto and nanoelectronics, displays, electro-physics**
- ▶ **Date : October 24, 2023 (*KST: UTC+09:00)**
- ▶ **Location : 301 Building, Room 920**

Invited Talks — 60 min. per presentation

Chair : Prof. Jeonghun Kwak

13:00 – 14:00	*Prof. Jaeyoun (Jay) Kim* (Iowa State University, USA) **Spatially Modulated Nanoimprinting of Photopolymer - Peculiarities and Applications**
14:00 – 15:00	*Prof. Ichiro IMAE* (Hiroshima University, Japan) **Control and quantification of carrier density of π–conjugated polymers using electrochemical methods and its application to the analysis of electrical properties**
15:00 – 16:00	*Dr. Gun-Yeal Lee* (Stanford University, USA) **Metasurface Optics for Next-Generation Displays**

SNU Talks — 10 min. per presentation

Chair : Dr. Taesoo Lee

Taesoo Lee	**Highly bright quantum dot light-emitting diodes based on the optimization of top-emitting structure** *(Advisor : Prof. Jeonghun Kwak*)
Ahyoung Hong	**Enhanced Charge Balance in Quantum Dot Light-Emitting Diodes with Rb_2CO_3 Interlayer** *(Advisor : Prof. Jeonghun Kwak*)
Beomsoo Chun	**Intermixing Behavior in Solution-Processed Organic Light-Emitting Diodes** *(Advisor : Prof. Jeonghun Kwak*)
Hyukjin Yang	**Role of material dispersion on light trapping in tapered metal-insulator-metal plasmonic waveguides** *(Advisor : Prof. Yoonchan Jeong*)
Hyukjn Go	**Strain-insensitive, stretchable piezoresistive pressure sensor** *(Advisor : Prof. Yongtaek Hong*)

CONTACT INFORMATION

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Spatially Modulated Nanoimprinting of Photopolymer - Peculiarities and Applications

Prof, Jaeyoun (Jay) Kim

Nanoimprinting of photopolymer is frequently employed for facile production of photonic devices. As the length-scale shrinks down to submicron regimes, however, the process becomes increasingly challenging. The photopolymers' inherent viscoelasticity makes their imprinting dynamics highly nonlinear and difficult to control. Moreover, most photopolymers exhibit relatively low refractive indices, making it difficult to apply many optical design rules that are optimized mainly for high-index materials. Reinforced research efforts are needed to address these nanoimprinting and device design issues altogether. This talk will take NOA73, a widely adopted photopolymer, as the model material and present the mechanical and optical peculiarities it exhibited along the author's proprietary process of "spatially modulated" nanoimprinting. How the resulting low-index structure was utilized for nanophotonics will also be discussed.

Biography

- 2021 - Present : Director of Graduate Education of the department, Iowa State University, USA
- 2006 - Present : Professor in Electrical and Computer Engineering Department, Iowa State University, USA
- 2003 – 2006 : Postdoctoral Fellow in Berkeley Sensor & Actuator Center (BSAC), University of California, USA
- 2003 : Ph.D in Electrical Engineering, University of Michigan, USA

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Control and quantification of carrier density of π-conjugated polymers using electrochemical methods and its application to the analysis of electrical properties

Prof. Ichiro IMAE

Since polyacetylene was successfully obtained as a film state and the bromine-doped film was found to show high electrical conductivities, π-conjugated polymers with various kinds of chemical structures have attracted a great deal of attention from many researchers because these polymers exhibit not only metallic nature in the doped (oxidized or reduced) state, but also semiconducting nature in the neutral state. While doped polymers were originally studied to understand the mechanism of electrical conduction from the fundamental aspects, neutral polymers have been well-studied over the last few decades from the viewpoint of their use in many types of applications in the plastic electronics field. Since it was found that poly(3,4-ethylenedioxythiophene) (PEDOT), a derivative of polythiophene, shows high electrical conductivity by chemical or electrochemical doping and the doped PEDOT can be applied to transparent conductive materials and organic thermoelectrics, doped polymers have started to attract attention again in very recent years. The electrical properties of π-conjugated polymers in the doped state depend on the carrier density introduced into the molecule. For example, electrical conductivity (σ) can be expressed as the product of carrier density (n), charge mobility (μ), and charge elementary mass (e) ($\sigma = ne\mu$). Seebeck coefficient (S), an important factor in organic thermoelectric materials, which have recently attracted much attention, is also known to have a close correlation with carrier density.

In this lecture, I will introduce a technique to control and quantify the carrier density injected into π-conjugated polymers by an electrochemical method called potential step chronocoulometry (PSC). Using potential-step chronocoulometry (PSC), the doping levels of π-conjugated polymers were controlled by the applied voltage and precisely quantified. In concert with the electrochemical oxidation of the polymers, the doping levels gradually increased and finally reached around 20–30%, suggesting that one positive charge is formed on every three to five monomer units. The maximum value of the doping levels was affected by the electron-donating natures of the polymers. The plot of log(doping level) vs. electrode potential fits a straight line in the low doping region, and saturated. The saturated values were changed depending on the chemical structures of the π-conjugated polymers. We found for the first time that in the logarithmic plot of the Seebeck coefficient and the doping level, a good linear relationship was obtained in a wide doping range from 1 to 20%, and the slope values were changed depending on the chemical structures of the π-conjugated polymers.

Biography

- 2018 : Visiting Professor, Huazhong University of Science and Technology, China
- 2018 : Adjunct Lecturer, Muroran Institute of Technology, Japan
- 2006 - Present : Associate Professor, Hiroshima University, Japan
- 1997 : Assistant Professor, Japan Advanced Institute of Science and Technology (JAIST), Japan
- 1994 - 1997 : Research Fellow of Japan Society for the Promotion of Science (JSPS), Japan
- 1992 - 1997 : M,S and Ph.D. in Engineering, Osaka University, Japan

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Metasurface Optics for Next-Generation Displays

Dr. Gun-Yeal Lee

Emerging technologies in displays have shown many promising applications on next-generation displays, including 3D displays and AR/VR displays, enabling transformative experiences in various domains such as entertainment, education, communications, and training. Nevertheless, the evolution of these next-gen displays is constrained by fundamental limitations in the existing optical and electrical device technologies, so there's an imperative need for innovative device technologies. Metasurfaces, which are planar optical elements composed of nanostructures, have unique optical characteristics not found in nature. Consequently, Metasurface-based optical elements, such as lenses, beam splitters, and waveplates, have garnered significant interest, primarily because of their potential to transcend the inherent limitations of conventional optical elements. These metasurface optical elements not only achieve functionalities unattainable with conventional optical elements but also offer superior performance and a more compact design, which is beneficial for the development of next-generation displays. In this talk, metasurface optical elements and their application to 3D holography and AR/VR display will be presented. I will outline the basic principles of nanophotonic structures and their design and fabrication methods to build metasurface optical elements. Then, I will discuss their applications for holography and AR/VR near-eye displays. To conclude, I will offer insights into some of my ongoing projects at Stanford and outline the prospective direction of my research geared towards pioneering next-generation optical display systems.

Biography

- 2022 - Present : Postdoctoral Researcher, Stanford University, USA
- 2021 - 2022 : Postdoctoral Researcher, Seoul National University, Republic of Korea
- 2015 - 2021 : Ph.D in Electrical and Computer Engineering, Seoul National University, Republic of Korea
- 2011 - 2015 : B.S. in Electrical and Computer Engineering & Physics, Seoul National University, Republic of Korea