SEMICONDUCTOR ENERGY LABORATORY

Development of High-Efficiency and High-Reliability Organic Light-Emitting Diode Materials and Devices

Background

Organic light-emitting diode (OLED) displays are commonly found in portable devices, monitors, and TVs used in everyday life. They offer superior performance compared to other displays, such as liquid crystal displays, in terms of lower power consumption and higher image quality, including wide color gamut, large contrast, and high still- and moving image resolution.

SEL is at the forefront of extensive R&D on OLED display technologies that provide high electro-optical conversion efficiency, low driving voltage, and long lifetime. One major achievement is the exciplex-triplet energy transfer (ExTET), an essential technology that is now widely used in OLEDs in commercially available smartphones and TVs.

The molecular structures of OLED materials are diverse and have a large number of substituents (partial structures). These substituents can be combined in many ways and structures with even slight differences significantly affecting the properties of OLED devices. For example, changes in driving voltage and electro-optical efficiency can drastically affect the power consumption of the end product. However, the molecular structure mechanisms behind these changes in OLED device performance are not yet fully understood. Therefore, elucidating the relationship between molecular structure and device properties is an essential topic that can contribute to improving the performance of OLED devices.

Goal

This project aims at understanding the relationship between the molecular structure of OLED materials and device properties to achieve high-performance OLED devices. The goal is to identify the properties of OLED materials required for creating high-efficiency and high-reliability OLED devices.

Tasks

1. Candidate OLED materials will be provided by SEL, but students with organic synthesis skills can also synthesize them independently.
2. Perform structural analysis of the OLED materials using nuclear magnetic resonance (NMR) and/or microcrystal electron diffraction (Micro ED) to analyze their three-dimensional structures.
3. Measure and analyze the mobility of holes and electrons in devices prepared by SEL.
4. Use high-performance computing to calculate stable structures of the OLED materials.
5. Summarize and discuss the results from 2-4.
6. Repeat steps 2-5 and perform comprehensive analysis and comparisons.

Required Qualifications

- B.Sc. degree in organic chemistry or a related field.
- Careful attention to safety and a sense of responsibility in handling organic solvents.
- Ability to learn and operate the analysis tools (NMR, Micro ED, or both) without difficulty; training is provided for 1-2 weeks.
- Experience in computational science or the ability to learn computational science without difficulty; training is provided for 1-2 weeks.
- Familiarity with data processing using Excel.
- Persistence in measurements and observation.
- Good communication skills in English. Japanese proficiency is an advantage but not required.

Contact information

This project is hosted by SEL. Students are invited to apply for a scholarship from SEL through the Sweden-Japan Foundation. For more information, please visit the SEL web site or contact the SEL public relations team at info@sel.co.jp.