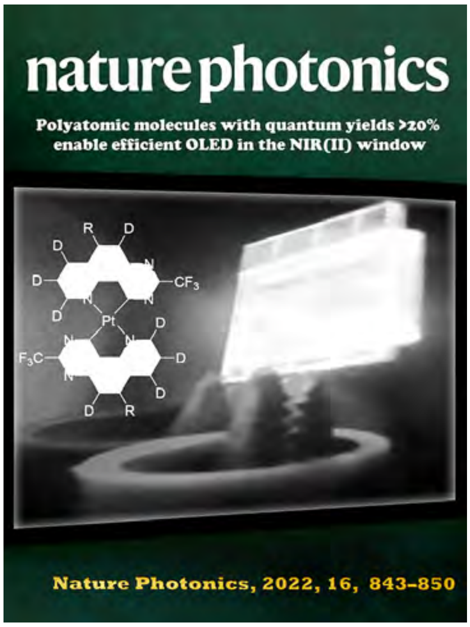
ACHIEVEMENTS

Record Breaking Research on Organic Strong Light Emission:

Polyatomic Molecules with Emission Quantum Yields> 20% Enable Efficient Organic Light-emitting Diodes in the NIR (II) Window

Share:

The research team led by Professor Pi-Tai Chou of the Department of Chemistry broke the world record for organic strong light emission—held by the team itself—of 840-930 nanometers and reaching 1000 nanometers. This stellar research achievement was published on October 10, 2022 in the renowned journal *Nature Photonics*.



Applying a strategy of platinum metal coordinated by more ϖ electron-conjugated, planarized ligand to facilitate self-assembly and replacement of C-H hydrogen atom of the ligand by deuterium, the exciton-vibration coupling has been drastically reduced. As a result, the highly intense near IR 1000 nm emission can be obtained, having an internal quantum yield of 21%, and an external quantum yield of 4.2% in OLED, both of which are world records.

The near-infrared (NIR) wavelength range of 1000-1700 nm is commonly known as the second infrared region (NIR(II)). It can pass through skin tissue and blood vessels for deep imaging detection. In addition, it is also an important wavelength range for optical fiber technology in information transmission because of reduced absorption loss. If NIR(II) emitting materials are to be considered for more general applications in the future, organic molecular materials with great synthetic versatility will be the best choice. However, the development for such applications has long been stymied by the “energy gap law,” that is, when the energy difference between the excited and ground states of an organic molecule is lower, the excitons-vibration coupling will be stronger, causing the relaxation of excitons to the ground state in terms of heat.

To breach this barrier, Professor Chou’s team decided to return to the theoretical basis of the problem in 2017. They considered that if the coupling is an inevitable law, then perhaps other methods could be used to reduce the coupling strength of the excitons/vibrations of organic materials in the NIR(II) region. Then, through a collaboration with Professor Yun Chi of National Tsinghua University, Professor Wen-Yi Hong of National Taiwan Ocean University, and Dr. Wei-Tsung Chuang of National Synchrotron Radiation Research Center, they successfully breached the barrier. Their article in *Nature Photonics* describes the brilliant strategy of using platinum metal coordinated by more ϖ electron-conjugated, planarized ligand to facilitate self-assembly, thus reducing the exciton-vibration coupling. By doing this and replacing the C-H hydrogen atoms in the ligand with deuterium to further reduce the contribution from exciton-high frequency vibration coupling, they broke through the shackles of the energy gap law, reaching 1000 nm emission with an internal quantum yield of 21%, as well as an external quantum yield of 4.2% in OLED, both of which are world records.

Click or Scan the QR code to read the journal article in *Nature Photonics*.