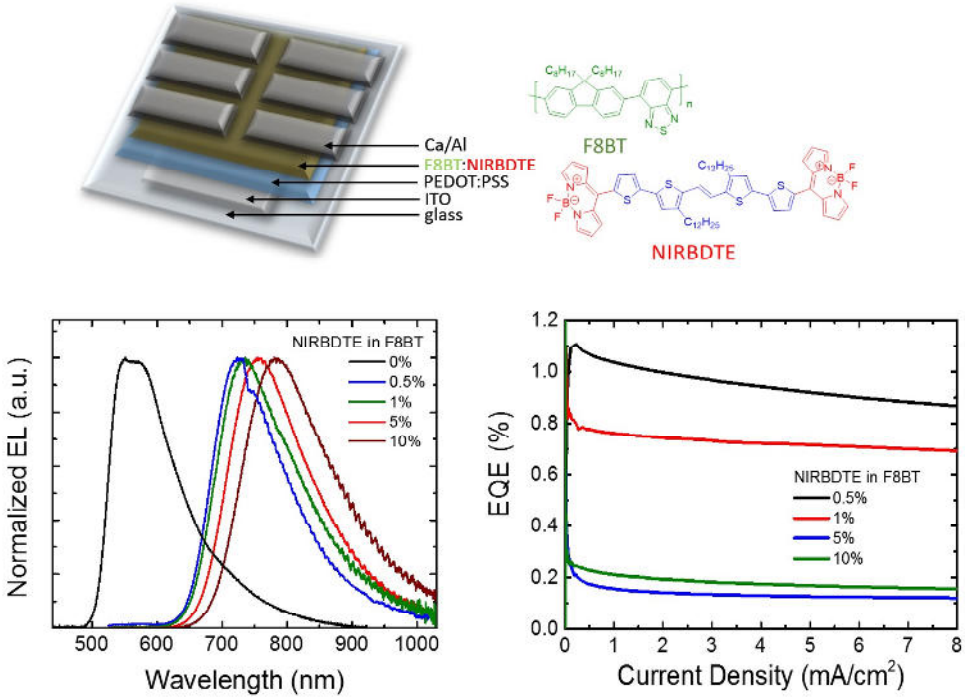
Highly Efficient Solid-State Near-infrared Organic Light-Emitting Diodes incorporating A-D-A Dyes based on α,β-unsubstituted "BODIPY" Moieties

A. Zampetti, A Minotto, B. M. Squeo, V. G. Gregoriou, S. Allard, U. Scherf, C. L. Chochos and F. Cacialli. *Sci. Rep.* **7**, 1611 (2017)
https://www.nature.com/articles/s41598-017-01785-2

A breakthrough has been achieved at the London Centre for Nanotechnology, where researchers from the Marie Curie initial training network (ITN) OSNIRO, alongside collaborators from Advent Technologies in Greece and from the University of Wuppertal (Germany) have shown record external quantum efficiencies for diodes based on organic red/NIR oligomers free from heavy/toxic metals and combining electron-withdrawing (A) moieties together with electron-donating (D) ones, in a previously poorly studied "A-D-A" motif.

Near-infrared (NIR) organic light-emitting diodes (OLEDs) are a burgeoning and unusual class of devices with a host of promising optoelectronic properties. Their potential in medical (from photodynamic therapy, to pulsi-oxymetry, and intracellular imaging), telecommunication (e.g. optical communication), and defence areas (night-vision devices, capillary mapping in identification systems, etc.) has commanded attention from both industry and academia although their luminescence efficiency is lower than achievable in the visible range, owing to the so-called "Energy gap law" according to which the non-radiative decay rate of an organic dye increases exponentially with reducing energy gap.

The international team have taken advantage of a recent breakthrough in the synthesis of a class of boron-containg moieties (4,4-difluoro-4-bora-3a,4a-diaza-s-indacenes, or BODIPYs in short), that were symmetrically conjugated with oligothienyls in an unexpectedly stable form, and then incorporated in a wider gap polyfluorene matrix. They were thus able to demonstrate OLEDs with emission peaking at 720 nm and external quantum efficiencies up to 1.1%, the highest value achieved so far by a NIR-OLED not containing toxic/heavy metals (thus also suitable for medical and potentially biocompatible applications). Their work demonstrates for the first time the promise of A-D-A type dyes for NIR OLEDs applications thereby paving the way for further optimisation.



NIR OLED structures, electroluminescence spectra (EL) and external quantum efficiency (EQE) versus current density curves of OLEDs incorporating the blend of the host polyfluorene with different NIRBDTE loading.