White-Light Electroluminescence from a Layer Incorporating a Single Fully-Organic Spiro Compound with Phosphine Oxide Substituents

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Supporting information
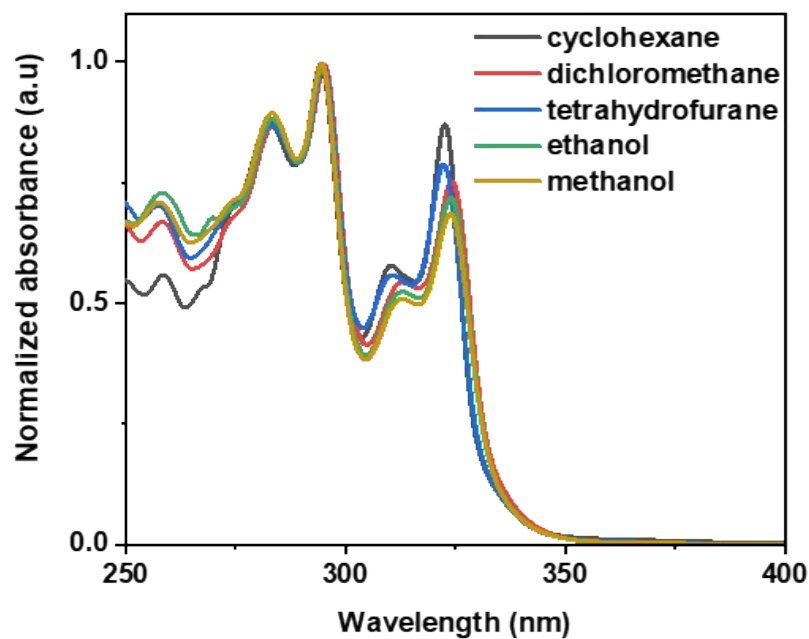
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Figure S1 *- Normalized absorption spectrum of **SPA-F-(POPh₂)₂** in different solvents recorded at room temperature without heating.*
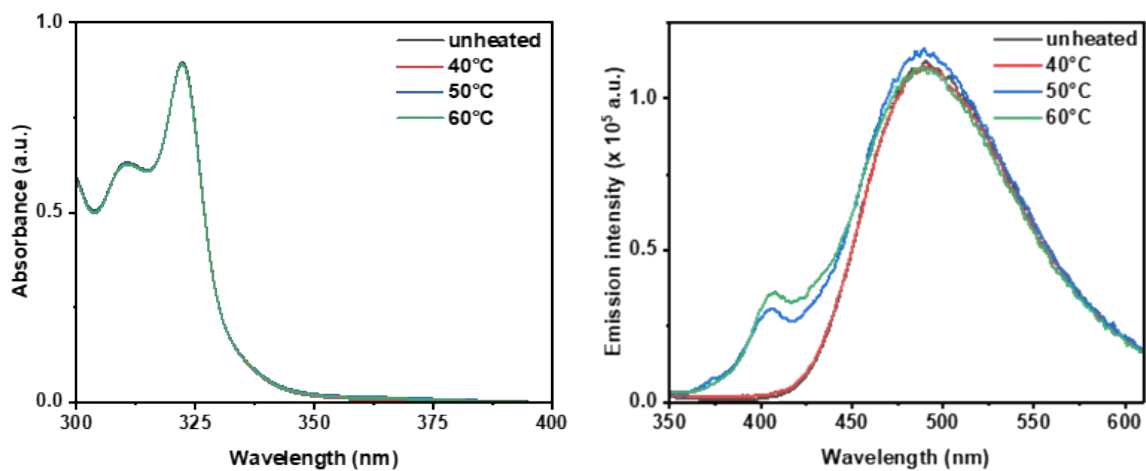

Figure S2 *- Evolution of the absorption (left) and emission (right) spectra of **SPA-F-(POPh₂)₂** in THF upon heating at a concentration of 4.4×10^{-5} mol/L. The solution is heated during 30 minutes for each temperature and the spectra are recorded once the solution has cooled down to room temperature.*
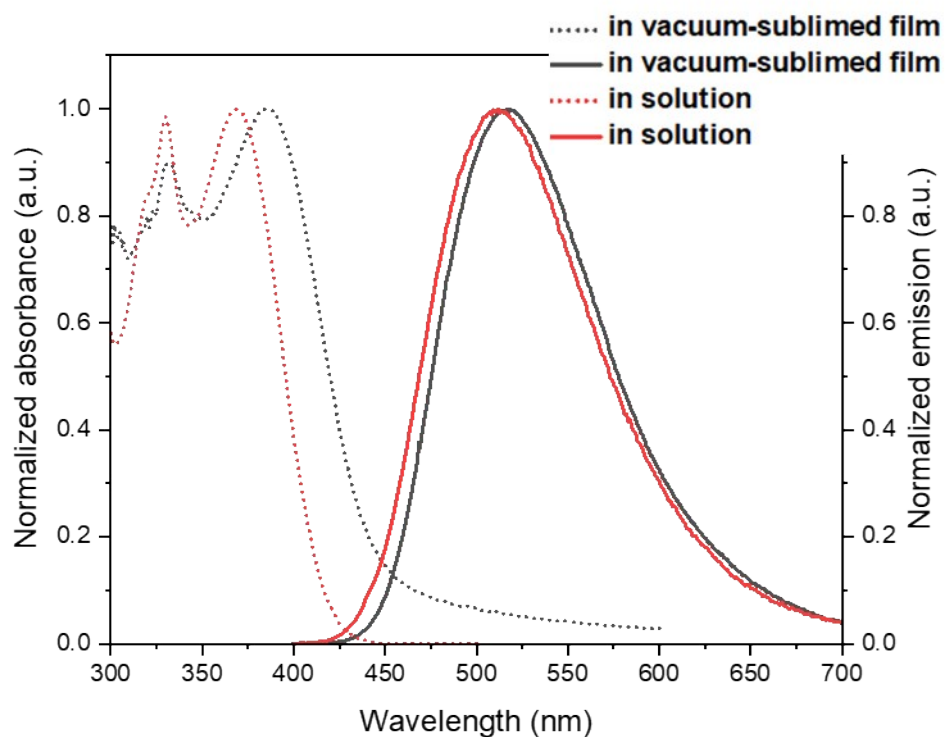
Figure S3 - *Absorption and emission spectra of 2CZPN in THF and in vacuum-sublimed films.*
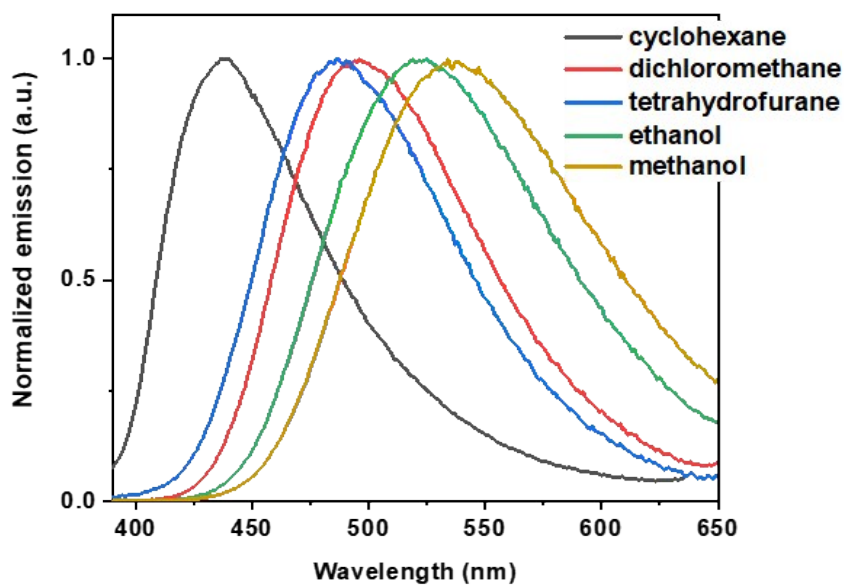

Figure S4 - *Normalized emission spectrum of **SPA-F-(POPh₂)₂** in different solvents upon excitation at 330 nm, as recorded at room temperature without heating (A$_{(330 nm)}$ <0.1). The concentration used is > 6×10^{-5} mol/L.*
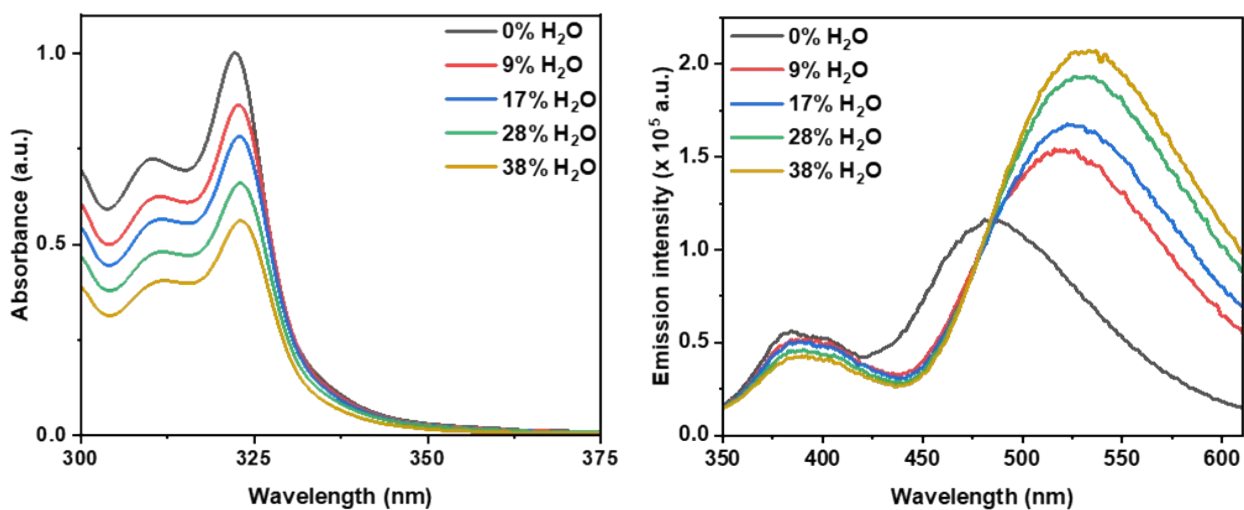
Figure S5 - *Evolution of the absorption (left) and emission (right) spectrum in THF upon progressive addition of water. The initial concentration is 4.8×10^{-5} mol/L.*
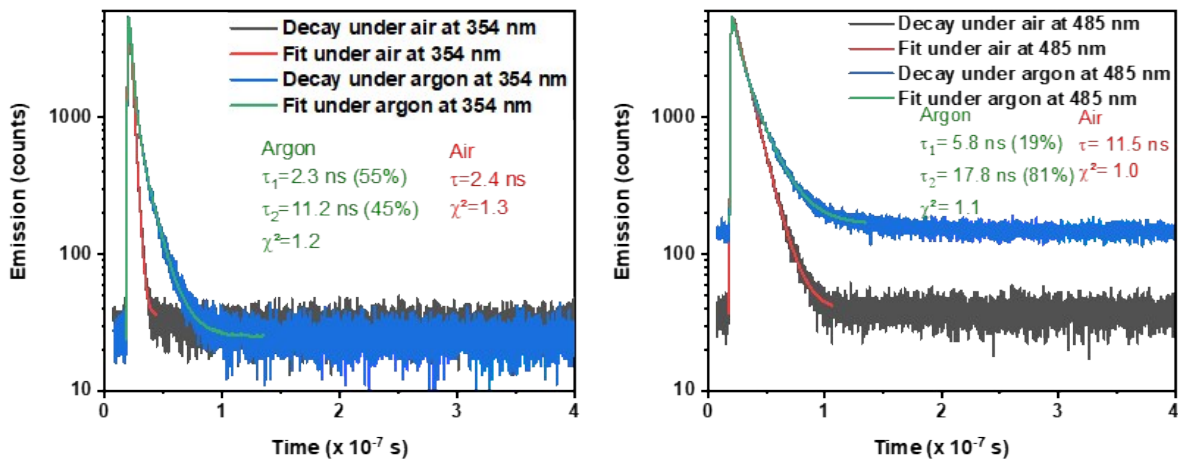

Figure S6 - *Transient PL decay of **SPA-F(POPh$_2$)$_2$** in THF under air (black) argon (blue) at (left) λ_{em} = 354 nm and (right) λ_{em} = 485 nm. The concentration is < $6x10^{-5}$ mol/L.*
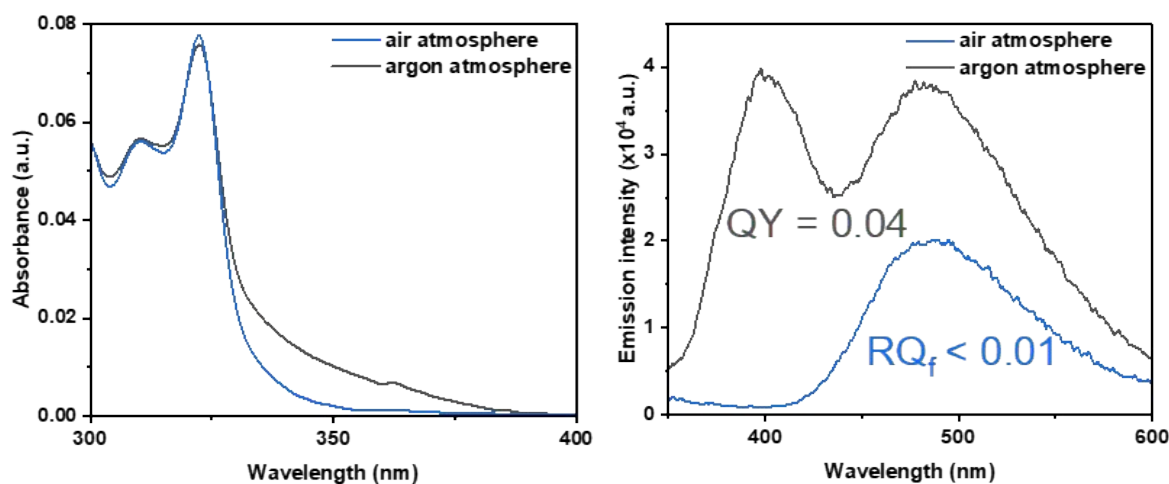
Figure S7 - *Absorption (left) and emission (right) spectra of* **SPA-F(POPh₂)₂** *in THF under air (blue) and argon (black). Quantum yields (QY) are noted in the right graph. The concentration is < 6x10⁻⁵ mol/L.*

Estimation of the fluorescence quantum yield

Quantum yields in solution (ϕ_{sol}) were calculated relative to quinine sulfate (ϕ_{ref} = 0.546 in H_2SO_4 1 N). ϕ_{sol} was determined according to the following equation:

$$\phi sol = \phi ref \times \frac{Ss \times Ar}{Sr \times As} \times \left(\frac{\eta_s}{\eta_r}\right)^2$$

where subscripts *s* and *r* refer respectively to the sample and reference, S is the integrated fluorescence intensity and A the absorbance at the excitation wavelength, η is the refractive index of the solvent (η_s = 1.405 for THF).

Film preparation

Thin films were prepared either by spin-coating ca 300 µL of a THF solution of **SPA-F(POPh₂)₂** on sapphire plate (10 mm × 10 mm) at 2500tr/min on a Süss₊MicroTec Lab Spin6/8 or by vacuum-deposition using a Kurt J. Leskers "Spectros" thin film evaporator system in glovebox (JACOMEX) and on a glass substrate.

OLED devices

General fabrication procedures

Commercial ITO coated-glasses from Naranjo have been used as patterned substrates for device fabrication. Prior deposition, substrates were first cleaned in different ultrasonic baths during 10 min with

solutions of 10% RBS detergent in demineralized water, tap water, demineralized water and acetone, and finally with an UV/ozone cleaning system from UVOCS.

All devices have been fabricated in glovebox (JACOMEX) with a Kurt J. Leskers "Spectros" thin film evaporator system.

Device encapsulation with a dense layer of Al_2O_3 has been carried out using an Atomic Layer Deposition (ALD) SAVANNAH 100 system (from Annealsys) in order to protect the devices prior measurements of the EQE.

Characterization:

Curves of current density (mA/cm²) and luminance (Cd/m²) have been obtained using a luminance meter LS-110 system from MINOLTA equipped with a 135 Lens model and a Keithley 2400 Source measuring unit.

The EQE of the devices have been calculated using the equation:

$$EQE = \frac{P_{ext}}{n_e} = \frac{\int_{380}^{780} \frac{Radiance}{Photon\ energy}}{\frac{J \times A}{q}} = \frac{\int_{380}^{780} \frac{W(\lambda)\, d\lambda}{h \times \frac{c}{\lambda}}}{\frac{J \times A}{q}}$$

where A is the device area, J the measured current density and q the charge of an electron.

The radiance (λ) spectrum of the devices has been measured with a LED analyzer OmniLED-LMS10 system from Labsphere equipped with a 10'' integrating sphere and a Keithley 2400 Source measuring unit. The use of an integrating sphere allows to collect all emitted photons in all directions and hence to avoid a correction in the emission spectrum with a Lambertian's law.

Color Recording Index (CRI) coordinates, from CIE, have been recorded with the same integrating sphere.

The turn-on voltages (V_{ON}) have been estimated from the crossing of the two tangents of the current-voltage curves.