Engineering luminescent systems based on transition metal complexes: design, self-assembly and applications

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In the last two decades, luminescent complexes based on second and third row transition metals (TMCs) have shown appealing properties and have been employed as active materials in different areas including bio-imaging, singlet-oxygen sensitization and optoelectronics (OLEDs, LEES). In these devices, due to the presence of a heavy metal that makes stronger the spin-orbit coupling, TMCs are able to efficiently harvest both singlet and triplet electrogenerated excitons, rising the theoretical internal quantum efficiency up to 100%. In particular, luminescent Ir(III), Pt(II) and Re(I) complexes play pivotal role due to their outstanding photo-physical properties.

Nowadays, the possibility to control long-range ordered architectures at the nano- and micro-meter scale which are based on either organic or organometallic functional materials represents a challenging research topic. Indeed, self-assembly through weak non-covalent interactions has been shown to provide a way to organize molecules in supramolecular structures with properties superior to common bulk materials.

During the talk, I will present my most recent advances concerning the design and characterization of highly efficient triplet emitters for optoelectronic applications. Also, the possibility to greatly modify and enhance their photophysical properties by formation of (self)-organized structures and/or application of external stimuli will be shown, and the mechanistic insights onto their supramolecular dynamics presented. Indeed, on one hand, such self-assembled structures possess outstanding photoluminescence quantum yield (PLQY) and long-lived excited state lifetime, as consequence of the shielding effect of the excited state exerted towards quenchers as dioxygen and water molecules. On the other hand, the long-range order yields to nano-organized supramolecular architectures, which can emit linearly polarized light with PLQY up to 75% or show amplification of the chiro-optical properties as consequence of their supramolecular organization.

Finally, the successful use of such self-assembled structures as a new set of labels in optical cellular bio-imaging will be demonstrated.