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Endohedral filling of single-wall-carbon NanoTubes for future opto-electronics

-Fonctionnalisation endohédrale de nanotubes de carbone mono-paroi pour l'optoélectronique du futur-

Keywords: Single-wall carbon nanotube, dyes, filling, chemical synthesis, inorganic chemistry, optical properties/spectroscopy, photoluminescence, device

Project positioning: Single-wall carbon nanotubes (SWCNTs) are well-known for their remarkable and unique electronic and optical properties, and these depend strongly on their exact diameter and structure named chirality. Thanks to the extensive variability of chiral structures (see figure 1), a large variety of electronic and optical properties can be accessed, making them extremely promising for diverse applications such as solar energy harvesting and high-performance (opto-)electronic devices. Besides these very peculiar intrinsic properties, SWCNTs also exhibit a hollow core, which can be filled with molecules giving rise to new 1-dimensional hybrids structure that merge the properties of the nanotube with those of the molecule[2]. In addition to being protected and isolated from the external environment, new properties for the encapsulated systems (new phases, phase transitions, and a significant increase in optical responses) can be observed due to the one-dimensional confinement imposed by the nanotube[3].

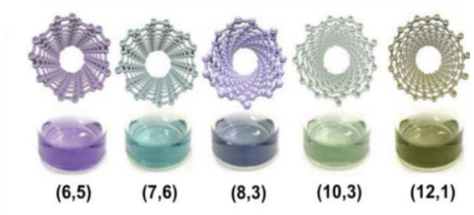

Figure 1 : Different structure of SWCNTs from [1]

PhD project: The objective is to synthesize and characterize new nanotube/dye structures to photosensitize nanotubes in the visible spectrum for solar cell applications. Indeed, while SWCNTs exhibit very narrow band absorption in a few discrete parts of the solar spectrum, the encapsulation of dye molecules that absorb light in complementary ranges, followed by energy transfer to the SWCNTs, should significantly improve the sensitivity of these devices. The phD will first synthesize new dyes (squaraine and dicyanodistyrylbenzene derivative in a first place) and encapsulate them in carbon nanotubes in order to characterize the molecule/nanotube interaction, in particular with respect to energy transfer. The final aim is to integrate the new hybrid system in a field effect transistor devices and measure photocurrent.

Practical details: The PhD will start in October 2023 in the Laboratoire des Multimatériaux et Interfaces (LMI), between the couche mince (COM) and the Chimie Inorganique Moléculaire et Précurseurs (CIMP) group. The PhD will also join the International collaborations with the University of Antwerp and the Karlsruhe Institute of Technology in Germany already agreed to measure photoluminescence in infrared and photocurrent, respectively.

Candidate desired skills: An interest in academic research and a background in physics-chemistry is highly recommended. Experience in both chemical synthesis and optical spectroscopy (UV, raman and/or photoluminescence) will be an strength.

Contact: You can contact us for additional information. Please send your applications (including the CV, motivation letters master's certificate with grades) to salome.forel@univ-lyon1.fr and cedric.desreoches@univ-lyon1.fr

References: **[1]** S. Abdulaziz et al. Adv. Funct. Mater, 2019, 29, 190227 **[2]** Sofie Cambré et al. Small, 2021, 17, 2102585 **[3]** S. Forel et al. Nanoscale, 2022, 14, 8385