ITI HiFunMat Master Internship Proposal

☐ M 1 ☒ M 2

Title: Design of carbon quantum dots (CQDs) for Fe^{3+} detection

Internship supervisor

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Collaboration with a HiFunMat member (*please indicate their name*)	☐ No ☒ Yes : Sébastien Albrecht Laboratoire d'Innovation Moléculaire & Applications, LIMA

Student profile looked for

Master program (*more than one box can be ticked)*	☒ Material science and engineering ☒ Chemistry ☐ Physics
Other indications if necessary	Experience in nanomaterial synthesis and/or characterization will be appreciated but not obligatory.

Internship description

The objective of this stage is to develop ratiometric fluorescent sensors based on carbon quantum dots (CQDs) for the detection of iron ions. Iron is present in the human body in different forms (Fe^{2+} and Fe^{3+}), and its detection is very important for the identification of various diseases. The today used technologies to detect iron are expensive, time-consuming, or lacking sensibility. For this reason, recent works explored the possibility of using CQDs for the detection of iron. CQDs attracted attention mainly due to their properties (biocompatibility, low toxicity, and good dispersion in water). They can be obtained by using a large variety of precursors which are eco-friendly and cost-effective via simple synthesis methods. The possibility of easy incorporation of nitrogen and sulphur in their structure, along with the particle size tuning, allow them to exhibit different fluorescent properties and selectivity toward iron detection.

The first part of the internship will focus on the synthesis of CQDs doped with nitrogen and sulphur, using hydrothermal carbonization and microwave routes. Several parameters will be investigated: the source of carbon, nitrogen, and sulphur, the concentration of precursors and solvent, and the operation conditions (temperature, time, and microwave power).

In the second part, the properties of the obtained materials will be characterised by several techniques: particle size by TEM (transmission electron microscopy), the surface chemistry by XPS (X-ray photoelectron spectroscopy) and Fourier transform infrared (FTIR) spectroscopy, and structure by Raman spectroscopy. The UV-VIS absorption and fluorescence spectra of the materials will be measured, and the obtained results will be linked with the properties of the materials.

Finally, the as-obtained materials will be used by LIMA partner to detect iron ions and to test the selectivity towards other ions present in human body (Na^{+}, Ca^{2+}, Mg^{2+} etc.). The promising materials will be tested for iron (III) detection at Institute of Research in Hematology and Transplantation (IRHT).