Master 2 internship

Synthesis of multifunctional nanoparticles as therapeutic agents for hyperthermia and radical-release cancer therapy

Host laboratory: Institut Charles Gerhardt Montpellier, Department Chemistry & Molecular Materials

Period: 6 months (or more) with flexible dates starting from November-January to July 2024

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Project description :

Below a critical size, iron oxide nanoparticles (Fe3O4) display a remarkable magnetic property: superparamagnetism. This property enables them to transform the energy of an alternating magnetic field (between 100 and 1000 kHz) into heat. This phenomenon is already in use at Berlin's Charité Hospital for the hyperthermal treatment of cancer, using a very high concentration of nanoparticles in a highly invasive manner. Research is currently focusing on reducing the concentration of nanoparticles in the human body for this type of treatment. The aim of this internship will be to develop a new multifunctional nano-object, consisting of a magnetic Fe3O4 core grafted with thermosensitive alkoxyamine molecules. The heat generated locally by the magnetic core will thermally activate the alkoxyamine to release radicals that are highly toxic to pathogens. These objects could thus be used in an innovative cancer treatment combining hyperthermia and radical release. A silica shell could be inserted between the Fe3O4 core and the alkoxyamine molecules to modulate heat transfer between the core and the heat-sensitive molecules. The in vitro tests will be performed on living cancer cells in order to verify the efficiency of treatment.
During this internship, the student will be trained in Fe3O4 nanoparticle synthesis techniques. He/she will then develop a protocol for grafting alkoxyamines onto the surface of the magnetic core. A follow-up study of radical release will then be carried out using a hyperthermia device and electron paramagnetic resonance (EPR) measurements. The student will perform the biological tests in vitro.

Profile: A particular affinity for inorganic and materials chemistry is expected. He/she will be required to use conventional materials characterization techniques (IR, UV-Visible, XRD, SEM EDX). Magneto-induced hyperthermia measurements will be carried out in the laboratory, as well as EPR measurements. Good organization, writing and presentation skills will be appreciated.

Skills acquired:

1. Project management, work at the interfaces of chemistry, nanochemistry, nanophysics and biology.
2. Synthesis and characterization of magnetic nanoparticles, their surface functionalization.
3. Magnetothermia measurements,
4. Hyperthermia in vitro