Offre de financement de thèse/ Thesis fellowship available at ENS (Paris)

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Collaboration with Carole Aimé, CR-CNRS, ENS-PSL UMR8640

Thématique/*title*
Re(CO)-based Nanoparticules for imaging (IR and X-fluorescence)

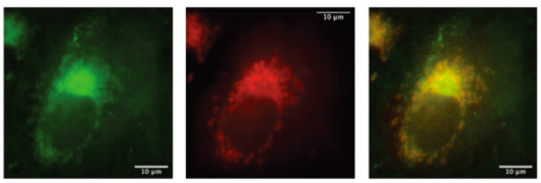
Champ/*scientific area*
Chemobiology, bioinorganic chemistry, cell biology
Materials chemistry, nanoparticles, spectroscopies (IR, X-fluorescence imagings)

How to apply? Send a CV, including some references (emails of former supervisors to be contacted) with a motivation letter to clotilde.policar@ens.psl.eu and nicolas.delsuc@ens.psl.eu

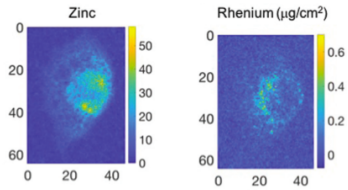
Description of the project

Bio-imaging, by enabling the visualization of biomolecules of interest, has proven to be highly informative in the study of biological processes. Although fluorescence microscopy is probably one of the most used techniques, alternative methods of imaging, providing complementary information, are emerging.[1,2] We have been developing non-conventional imaging techniques, including IR-imaging —interesting as IR-signature is specific to a chemical function and X-fluorescence imaging —interesting as highly focalized X-ray beams are now available on synchrotrons, leading to new opportunities of sub-cellular mapping of heavy elements such as metal ions.

We have previously shown that $[ReCl(CO)_3(pyta)]$ can be used as multimodal probes for imaging by UV-vis fluorescence, IR and X fluorescence.[2–5] In the mid IR range, the CO coordinated to the Re core absorb the energy at ca 2000 cm^{-1}, an energy at which biological media are transparent (no energy absorbed).[4] Recently, we have been able to design low-molecular weight organelle trackers based on a Re(CO) core (see for example figure below, in the case of a mitotracker[5]).



A. Classical fluorescence. Green: Re(CO) probe, Red: commercially available mitotracker, Yellow: merge



B. X-Fluorescence imaging of the sme Re(CO) probe. Naturally occurring Zn, showing the nucleus and Re, displaying a perinuclear distribution

Figure: Imaging of cells incubated with a Re-based probe tracking the mitochondria. From ref 5.

The development of IR/X-fluorescence probes is a real challenge, with a key issue of sensitivity. We thus want to investigate the opportunity to incorporate these $[ReCl(CO)_3(pyta)]$ into silica nanoparticles (SiNPs) to obtain a high density of probes and hence improved significantly the sensitivity. SiNPs are wide-spread materials easy to synthesize, easy to modify and with a low cytotoxicity.[6–8] We will modify them by surface functionalization, with peptides for instance, to target specific cells (e.g. cancerous cells). We will assay them for bio-imaging and other application will also be explored.

2. Techniques: inorganic synthesis, including polymerization, synthesis and functionalization of SiNPs, cell biology (toxicity), FTIR, IR-imaging, X-fluorescence imaging

We will explore different strategies for synthesizing a silica precursor functionalized with $[ReCl(CO)_3(pyta)$. SiNPs will then be synthesized using a sol-gel route and further characterized using

electron microscopy and light scattering. ReSiNPs will be studied in cells in order to evaluate their **toxicity** and **sensitivity of the detection in the IR**. We will also investigate **classical fluorescence** imaging, as a control, and **X-fluorescence synchrotron-based imaging** working at the Lß-edge of Re (~10.15 and 10.28 keV), as we have previously performed with a protein tagged with a similar (pyta)$Re(CO)_3$ probe.[2] We will then **functionalize** the SiNPs with **targeting peptide moieties** in order to achieve specific biological targeting.

3. Références / *References*

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