Design and synthesis of fluorinated nanomaterials and their applications

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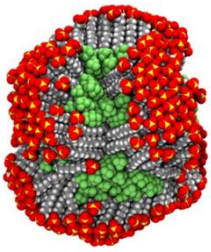
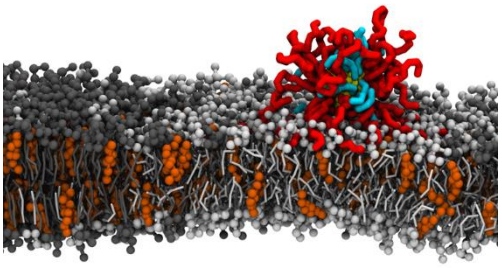
This project is focused on Fluorinated Nanoparticles, a hybrid organic-inorganic material with applications that span from drug delivery, contrast agents to sensors and remediation from PFAS.



Fluorinated compounds gained increase importance in the last decades due to the absence of fluorine from most biological systems and this has imbued fluorinated materials with particular properties of importance in treatment and diagnosis. Notably, the replacement of H by F in alkyl chains leads to enhanced hydrophobicity and stiffness, and promotes self-assembly, ordered stacking, and segregation between fluorinated and non-fluorinated moieties. Thus, synergistically combining the physical-chemical properties of the inorganic core of nanoparticles with those of the fluorinated compounds is very attractive to develop new materials.

Our group is particularly interested in the chemistry of fluorinated nanoparticles, from the investigation and engineering of their properties, up to their application. Examples are the study of fluorinated gold nanoparticles well dispersible in aqueous media,[1] the engineering of fluorinated nanoparticles for MRI and drug delivery, the investigation of their interaction with biological systems.[2]



The approach to the preparation of this type of material has been well set up and within this project it would be adapted to different inorganic nanoparticles and new type of applications will be explored.

The PhD student will develop both synthetic and instrumental skills. The synthesis of fluorinated molecules, as well as organic-inorganic nanoparticles will be performed. The obtained materials will be analysed with state-of-the-art spectroscopic methods, including nuclear magnetic resonance (NMR), optical spectroscopies, infrared spectroscopy (IR), transition electron microscopy (TEM), and analytical methods such as dynamic laser scattering (DLS), thermogravimetric analysis (TGA), differential scanning calorimetry (DSC). Our group has also fruitful collaborations for a multidisciplinary approach to study the new materials, that involve also electron spin resonance (ESR), magnetic resonance imaging (MRI), computational analyses.

Typically, the PhD work starts from a project that is ongoing in the group. Then, the individual interests and attitudes of the student come into play and shape the development of their path into research.

References:

[1] "Water-soluble gold nanoparticles protected by fluorinated amphiphilic thiolates". C. Gentilini, F. Evangelista, P. Rudolf, P. Franchi, M. Lucarini, L. Pasquato, *J. Am. Chem. Soc.* **2008**, *130*, 5678. "Formation of patches in 3D monolayers driven by thiols with immiscible chains observed by ESR spectroscopy". C. Gentilini, P. Franchi, E. Mileo, S. Polizzi, M. Lucarini, L. Pasquato, *Angew. Chem. Int. Ed.* **2009**, *47*, 3060.

[2] "Gold nanoparticles protected by fluorinated ligands for ^{19}F MRI". M. Boccalon, P. Franchi, M. Lucarini, J. J. Delgado, F. Sousa, F. Stellacci, I. Zucca, A. Scotti, R. Spreafico, P. Pengo, L. Pasquato, *Chem. Commun.* **2013**, *49*, 8794. "Gold nanoparticles as drug carriers: a contribution to the quest of basic principles for monolayer design". M. Boccalon, S. Bidoggia, F. Romano, L. Gualandi, P. Franchi, M. Lucarini, P. Pengo, L. Pasquato, *J. Mater. Chem. B.* **2015**, *3*, 432. "Mixed Fluorinated/Hydrogenated Self-Assembled Monolayer-Protected Gold Nanoparticles: In Silico and in Vitro Behavior". D. Marson, F. Guida, M. Şologan, S. Boccardo, P. Pengo, F. Perissinotto, V. Iacuzzi, E. Pelizzoni, S. Polizzi, L. Casalis, L. Pasquato, S. Pacor, A. Tossi, P. Posocco. *Small*, **2019**, *15*, 1900323.