Università degli Studi di Torino

Dipartimento di Chimica

TBM

TOXICITY and BIOCOMPATIBILITY of MATERIALS

# Proposte tesi A.A. 2017/2018

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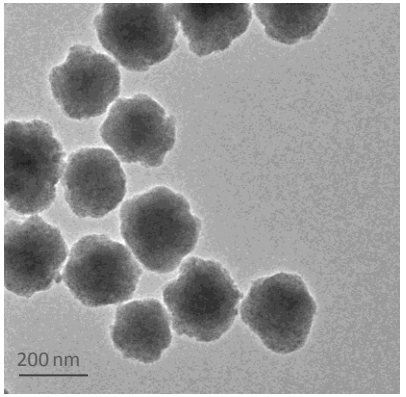
# 1. Developing magnetic carbon nanohybrids with controlled biodegradability

## Background

Iron oxide nanoparticles (FeOx-NPs) are currently used as contrast agents in MRI. They are also studied for therapeutic applications. Because of their superparamagnetic properties, FeOx-NPs generate heat by applying a magnetic field (thermal therapy) or may be transported by a magnet in the target organ. Once their action is finished the nanoparticles have to be eliminated. The FeOx-NPs are known to dissolve in biofluids. This process have to be controlled to avoid iron overload that may induce oxidative tress.

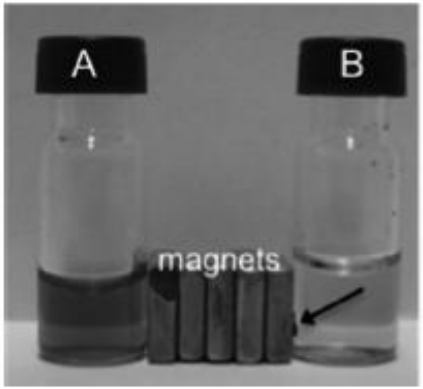
## Aims of the project

In this project different synthetic protocols to produce magnetic nano-hybrids by association of iron oxides and elemental carbon will be explored. The pro-or antioxidant properties will be evaluated. Furthermore, the in vitro biodegradability of the nanoparticles will be studied by using solutions simulating the phagolysosomial fluid. The project is conducted within a collaboration with the Royal College of Surgeons in Ireland




## Methods

Electron Paramagnetic Resonance (EPR)
UV-vis Spectroscopy
Synthesis
Dynamic Light Scattering (DLS) e Electrophoretic Light Scattering (ELS)



# 2. Mechanisms of interaction with the cellular redox homeostasis of carbon nanoparticles

## Background

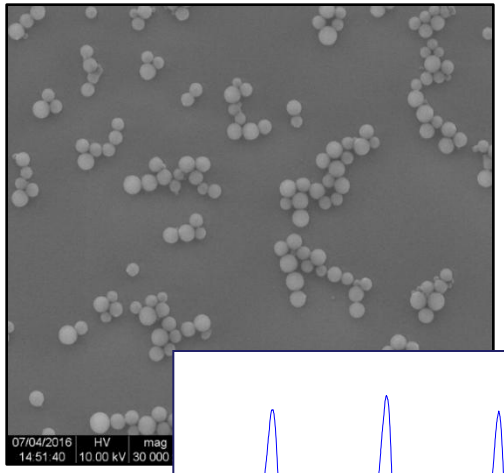
Thermal therapy and photodynamic therapy are among the most innovative field of application of inorganic nanoparticles. Some nanomaterials are, in fact, able to generate heat or reactive Oxygen Species (ROS), if irradiated with magnetic field or electromagnetic radiations. Recently in our laboratories photo-active elemental carbon nanoparticles have been developed. However if not activated they are not inert. Preliminary data showed that these nanoparticles are able, on one side, to scavenge hydroxyl radicals, and on the other to oxidise thiols.

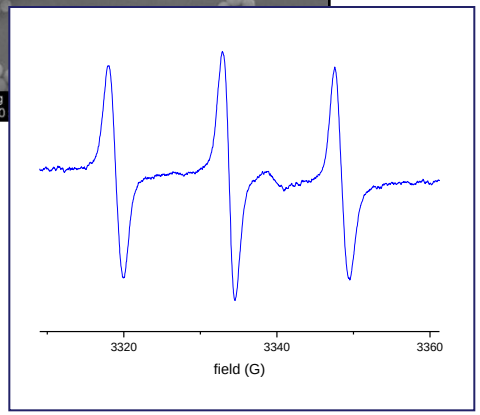
## Aim of the project

The project will be focuses on the study of the redox properties of elemental carbon nanoparticles synthesized by a hydrothermal route by means of cell-free tests. The project will integrate the activities of Dr. Ida Kokalari (dottorato di Medicina Molecolare) and it might include a validation of the pro/anti-oxidant properties on a cell line (in collaboration with the Dip. di Oncologia, to be confirmed).

## Methods

Electron Paramagnetic Resonance (EPR)
UV-vis Spectroscopy
Synthesis
Dynamic Light Scattering (DLS) e Electrophoretic Light Scattering (ELS)
(In vitro cellular tests)



# 4. Screening the inhibitory effect of soluble and insoluble nanoparticles on the enzyme aconitase: a possible pathway of cell injury

## Background

The knowledge of the molecular events that initiate the adverse response of an organism to a chemical is a key step for the definition of structure activity relationships and for the development of markers of toxicity. One of the properties that are know to modulate the toxicity of nanomaterials is the ability to interfere with the redox homeostasis of cells that lead to inactivation of enzymes containing iron sulfur cluster [FeS].

Aconitase is a mitochondrial enzyme that catalyses the isomerization of citrate to isocitrate in the tricarboxylic cycle. The enzyme binds to a [$Fe_4S_4$] prosthetic group essential for its function and susceptible to inactivation by ROS that targets the single unligated iron atom present in the [$Fe_4S_4$] cluster, leading to its instability with subsequent inactivation of the enzyme. Aconitase is a suitable candidate to became a marker for redox unbalance promoted by nanomaterials.

## Aims of the project

In this project a series of nanomaterials of different chemical nature (iron oxides, silica, carbon nanotubes) procured or purposely synthesized will be tested for their ability to interfere with the enzymatic activity of aconitase. The experiments will be focused in identifying new adverse outcome pathways (AOP) and, possibly, of new markers of toxicity that may be used for the diagnosis of pathologies.

The project will be conducted in collaboration with Prof. Salvatore Adinolfi (Dip. di Scienza e Tecnologia del Farmaco).

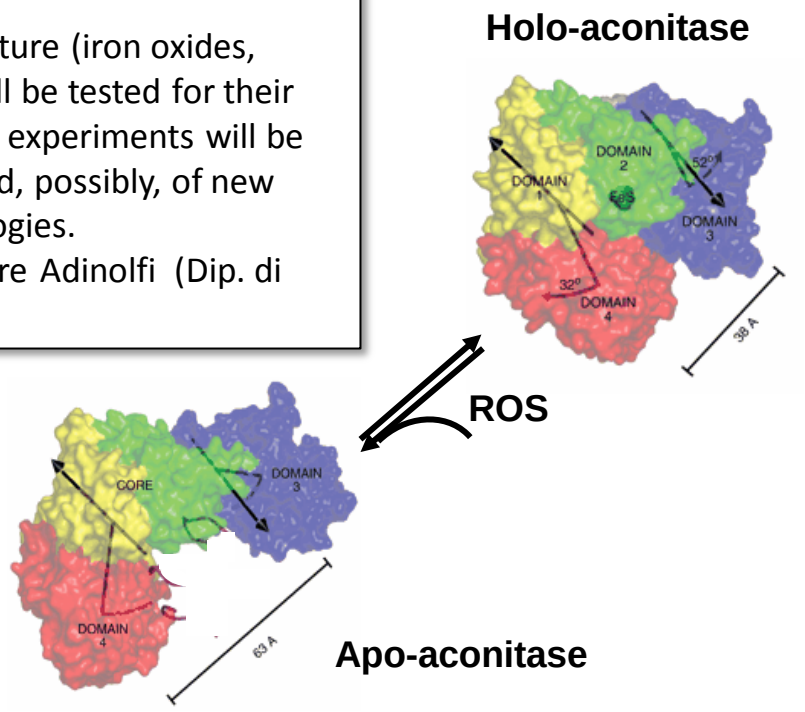
## Methods

Nanomaterials synthesis and characterization

Protein purification

Enzymatic assay

UV-VIS spectroscopy



# Overview of further possible topics (depending upon founding...)

**Molecular mechanisms of interaction of nanomaterials with nucleic acids**

**Molecular mechanisms of interaction of nanomaterials with proteins**

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**Characterization of surface contaminants of nanomaterials**

**Development of methods and techniques for materials hazard or biocompatibility assessment**