MASTER CHEM BIO&MAT

CHEMISTRY at the Interface with BIOLOGY and MATERIALS Science

INVITED LECTURE

12.15 h · Friday July 18th, 2025

Hybrid responsive nanomaterials for biomedical applications

by Prof. Luisa De Cola

University of Milano. Department DISFARM

Istituto di Ricerche Farmacologiche Mario Negri, IRCCS · Milano

Institute of Nanotechnology, Karlsruhe Institute of Technology (KIT), Germany

Location: CiQUS | Seminar Room (Ground Floor)

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Advancements in the use of nanoparticles for biomedical applications have clearly shown their potential for the preparation of improved imaging and drug-delivery systems. However, only a few successfully materials translate into clinical practice, because, of their incomplete elimination, difficulties to cross barriers and lack of selectivity. We have recently reported disulfide-bridged organosilica nanoparticles with cage-like morphology, and assessed in detail their toxicity and bioaccumulation in vitro and in vivo [1-3]. With such particles we have performed drug delivery in the attempt to slow down the growth of tumors as in the case of the very malignant mesothelioma tumor. The use of a platinum based drugs showed that the growth of the tumor can be reduced up to 50% in the case of the encapsulation of the metallodrug and its release vs the free drug.

But how to target specific organs or cancer tissues?

To improve selective uptake we have recently developed a technology based on the use of extracellular vesicles, EVs. Through a strategy we are able to separate the membrane of these vesicles and reconstruct it on top of our nanomaterials. The membrane contains all the original targeting proteins and receptors and depending from which tumor is isolated able to target specific organs or metastasis. We show that not only in vitro we have an excellent selectivity, but also in vivo we are able to demonstrate an excellent selectivity towards cancer cells vs normal cells of the same tissue. [4]

The use of melanoma EVs showed a tropism, of the hybrid materials, towards lungs and quantitative analysis on mice models suggested that the targeting behavior of the EVs can be indeed used as a strategy for the targeting of lungs and reduces dramatically the accumulation in liver.

Finally, silica nanoparticles containing single-stranded nucleic acids, that are covalently embedded in the silica network, have been developed and investigated [5]. The system can be programmed to be more dynamic and responsive by designing supramolecular organo-silica systems based on PNA- derivatives that can self-assemble through direct base paring or can be joined through a bridging functional nucleic acid, such as the ATP-binding aptamer [6].

These systems can be followed by confocal microscopy in different cell lines and their biological effect was measured in cells to assess the biological effect of the aptamer.

References

[1] P. Picchetti et al. *ACS Nano* **2021,** *15,* 9701–9716
[2] P. Picchetti, et al. *J. Am. Chem. Soc*. **2021**, *143*, 7681-7687.
[3] M. Sancho Albero, et al. *Adv. Healthcare Mater*., **2023**, *12*, 2202932
[4] M. Sancho Albero, et al. *Materials Today Bio*, **2025**, *30*, 101433
[5] P. Picchetti et al *J. Am. Chem. Soc*. **2023**, *145*, 22896-22902
[6] P. Picchetti et al *J. Am. Chem. Soc*. **2023**, *145*, 22903-22912.

Luisa De Cola is since November 2020 Professor at the University of Milan and head of the unit Materials for Health at the Istituto di Ricerche Farmacologiche Mario Negri, IRCCS, Italy. She is also part time scientist at the INT-KIT, Karlsruhe, Germany.

She was born in Messina, Italy, where she studied chemistry. After a post-doc in USA she was appointed Assistant Professor at the University of Bologna (1990). In 1998 she was appointed Full Professor at the University of Amsterdam, The Netherlands.

In 2004 she moved to the University of Muenster, Germany. In 2012 she has been appointed Axa Chair of Supramolecular and Bio-Material Chemistry, at the University of Strasbourg. She is recipients of several awards and recognitions, the most recent being the Izatt–Christensen Award in Macrocyclic and Supramolecular Chemistry (2019), the gold Medal Natta (2020), the Centenary Prize from the Royal Society of Chemistry (2024) and the Nitti-Casassas Award 2025. She has been nominated "Chevalier de la Légion d' Honneur" by the President of the French Republic, François Hollande; elected member of the German National Academy of Sciences Leopoldina, of the Accademia dei Lincei and fellow of the American Institute for Medical and Biological Engineering (AIMBE).

She is the editor in chief of Chemistry Europe.

Her main interests are: supramolecular assemblies, labels for diagnostics, and nano- and porous structures for biomedical applications. She has published more than 400 papers and filed 40 patents. She is the cofounder of the spin-off Bionys, dealing with diagnostics in vitro.

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2024-2025 Introductory Research Projects

MASTER CHEM BIO&MAT — CHEMISTRY at the Interface with BIOLOGY and MATERIALS Science

Poster Session

09.30 · 11.00 h · Friday July 18th, 2025

P1 · **Comparison of oxime and native chemical ligation for autocatalytic peptidde amphiphile synthesis**
Blessing O. Taimi,* Ion Turcan, Edgar Castanheira, Ignacio Insua

P2 · **Lipid nanoparticles for EGFP-mRNA delivery in vitro**
Adetutu Oyinloye,* Sajid Fazal, Beatriz Pelaz, Pablo del Pino

P3 · **Molecular design of radical-based covalent organic frameworks for energy storage applications**
Sara Trigo,* Paula Escamilla, Manuel Souto

P4 · **Photophysical study of the azide-thioalkyne cycloaddition promoted by photoactivatable ruthenium complexes**
Laura Parada Pérez,* Fernando López, José Luis Mascareñas, Laura Rodríguez Raurell

P5 · **Towards light-induced self-assembled antimicrobial cyclic peptide nanotubes**
Martín Vázquez,* Sergio Serantes, Marcos Vilela, Juan R. Granja, Manuel Amorín

with Prof. Luisa De Cola

Location: CiQUS Corridor | Ground Floor

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