Hybrid and supramolecular (nano)materials for biomedical applications

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Design and realization of materials able to be biocompatible, degradable and programmed to target only desired organs and/or cells is a major challenge that involve several disciplines.
We have for several years focused on organosilica nanoparticles able to break once they are internalized in cells and showed that it is possible to change morphology, size and porosity. Very recently we have shown that cage type structure of small dimension (20 nm) can escape macrophage filtering [1] and reach the tumor site. Such findings have been tested to study the therapeutic effect of such nanocarriers for fighting the malignant pleural mesotelioma. In vivo data showed an interesting 50% reduction of tumor growth when mice were treated with a Pt(IV) prodrug, entrapped in the nanocages, at an equivalent dose of the free platinum complex [2]. To improve the biomimetic behavior such nanomaterials can be covered with a lipidic layer to improve the hemocompatibility and improve cell uptake rendering the nanomaterials biomimetic [3].
Finally silica nanoparticles incorporating synthetic nucleic acids and analogs as constitutive components of the organosilica structures are discussed. Interestingly different nanomaterials containing single-stranded nucleic acids that are covalently embedded in the silica network, that respond to various biological, physical, and chemical inputs through detectable physicochemical changes [4]. 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 [5].

References:

[1] *ACS Nano* **2021**, *15*, 9701–9716
[2] *Adv. Healthcare Mater.* **2023**,*12*, 2202932
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[4] *J. Am. Chem. Soc.* **2023**, *145*, 22896-22902.
[5] *J. Am. Chem. Soc.* **2023**, *145*, 22903-22912.

Biosketch Prof. Luisa De Cola

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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, the most recent being the Izatt–Christensen Award in Macrocyclic and Supramolecular Chemistry (2019), the gold Medal Natta (2020). She has been Nominated “Chevalier de la Légion d' Honneur” by the President of the French Republic, François Hollande, and she is a 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).

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