Hybrid responsive materials for bio-applications

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Luisa De Cola is since November 2020 Professor at the University of Milan and 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), the Nitti-Cassas Award and the Ziegler Natta prize 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*.

Abstract of the talk. Hybrid responsive materials for bio-applications

The use of silica nanoparticles has been explored in the biomedical field for drug delivery, sensing and imaging. We have developed a strategy to obtain silica nanosystems breakable on demand and in particular the insertion of disulfide groups inserted into the silica framework allows the nanoparticles to be destroyed intracellularly. The surface can be functionalized with different

targeting units as well as the morphology canbe changed in order to obtain single pore nanoparticles[1].
The organic groups can also be oligonucleotides and, in particular, silica nanoparticles containing single-stranded nucleic acids, that are covalently embedded in the silica network, have been developed and investigated [2]. 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 [3].
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.
Besides these more obvious applications, the use of silica nanocapsules has also proved to be an interesting way to enhance coral settlement through the development of biomimetic microhabitats that replicate the chemical landscape of healthy reefs. Responsive capsules able to entrap large biomolecules are described, and embedded in a hydrogel to slow down the release of the actives [4]. We engineered a soft biomaterial, SNAP-X, composed of silica nanoparticles, biopolymers and algal exometabolites, to enrich reef microhabitats with bioactive molecules from crustose coralline algae. Coral settlement was enhanced over 20-fold using SNAP-X coated substrates compared to uncoated controls. SNAP-X is designed to gradually release chemical signals slowly (> 1 month) under natural seawater conditions, and it can be rapidly applied to natural reef substrates via photopolymerization, further facilitating the light-assisted 3D printing of microengineered habitats

References
[1] P. Picchetti et al. ACS Nano 2021, 15, 9701–9716; P. Picchetti, et al. J. Am. Chem. Soc. 2021, 143, 7681-7687.
[2] P. Picchetti et al J. Am. Chem. Soc. 2023, 145, 22896-22902
[3] P. Picchetti et al J. Am. Chem. Soc. 2023, 145, 22903-22912.
[4] D. Wangpraseurt et al. Trends in Biotechnology, 2025, asap, https://doi.org/10.1016/j.tibtech.2025.03.019;
Science May 2025, doi: 10.1126/science.znlhrh6