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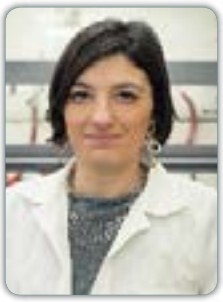

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Hybrid smart nanocrystals and the shielding effect of phospholipid bilayer for biomedical application

Statement of the Problem: Zinc oxide nanocrystals (ZnO NCs), thanks to their unique properties, are receiving much attention for their use in nanomedicine, in particular for therapy against cancer. To be efficiently employed as diagnostic and therapeutic (yet theranostic) tools, highly dispersed, stable and non-toxic nanoparticles are required. In the case of ZnO NCs, there is still a lack of knowledge about cytotoxicity mechanisms and stability in the biological context, as well as immunological response and hemocompatible features. We thus propose a novel approach to render stable, immune and hemocompatible ZnO NCs in various biological media using artificial and natural phospholipidic bilayers.

Methodology & Theoretical Orientation: We synthesized amino-functionalized ZnO NCs, then shielded with phospholipid bilayers either from synthetic origin or natural biovesicles. We characterized their structural, morphological, physico-chemical properties, focusing on the coupling mechanism between ZnO NCs and the lipid vesicles. The stability behavior of different hybrid nanocrystals was evaluated, comparing their biodegradation profiles in different inorganic and biological media. The study aims to investigate how the particle surface chemistry and charge could influence their aggregation/degradation in the different media and interaction with cells. We actually proved their hemocompatibility in human plasma and their internalization into cancer cells and related cytotoxicity mechanisms. A stimuli responsive activation by UV-light was investigated for inducing high mortality of cancer cells based on the hybrid NCs.

Findings: We demonstrated that pristine ZnO NCs strongly aggregate when suspended in both simulated and biological media, showing small dissolution into potentially cytotoxic Zn-cations, also slightly affecting their crystalline structure. In contrast, high colloidal stability and integrity was retained for hybrid lipid-shielded ZnO NCs in all media, accompanied by high biocompatibility, efficient cell internalization and effective killing ability only upon stimuli-activation. These features render these hybrid ZnO NCs ideal "Trojan horses" for further theranostic applications.

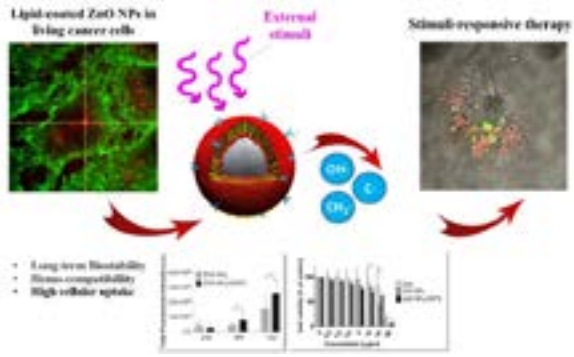

Figure 1: Scheme of the hybrid nanocrystal, as a Trojan horse showing higher bio- and hemocompatibility, long-term stability in various biological and inorganic fluids, improved cell internalization with respect to pristine ZnO NCs. A stimuli responsive behavior, guided by UV-light is also reported.

Recent Publications

1. Racca L et al. (2018) Zinc Oxide Nanostructures in Biomedicine. In Smart Nanoparticles for Biomedicine. Elsevier Pages:171-187. Doi:10.1016/B978-0-12-814156-4.00012-4.
2. Lim E et al. (2015) Nanomaterials for theranostics: recent advances and future challenges. Chem. Rev. 115(1):327-394. Doi:1021/cr300213b.
3. Dumontel B et al. (2017) Enhanced biostability and cellular uptake of zinc oxide nanocrystals shielded with phospholipid bilayer. Journal of Materials Chemistry B 5(44):8799-8813. Doi:10.1039/c7tb02229h.
4. Ancona A et al. (2018) Lipid-coated zinc oxide nanoparticles as innovative ROS-generators for photodynamic therapy in cancer cells.

Biography

Valentina Cauda pursued her PhD in Material Science and Technology (2008) from Polytechnic University of Torino, Italy. She is graduated in Chemical Engineering (2004). She is currently an Associate Professor at the Polytechnic University of Torino. In 2006, she was a visiting PhD student at the Complutense University of Madrid (Spain). From 2008 to 2010, she worked as Postdoc at the University of Munich (Germany). From 2010 to 2015 she was a Senior Postdoc at the Istituto Italiano di Tecnologia (Italy). For her research work she received several prizes: Young Researchers at the University of Munich (2010); the Italian "Giovedì Scienza" award (2013); Zonta Prize for Chemistry (2015) and the USERN Prize for Biological Sciences (2017) respectively. In 2016 she was awarded by the European Research Council with an ERC Starting Grant. She is the author of 84 papers in peer-reviewed international journals with H-index of 28

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