VIDEO ARTICLE

Vid. Proc. Adv. Mater., Volume 2, Article ID 2102137 **(2021)**

Biocompatible and Bio-Inspired Micro- and Nano-Structures for Nanotheranostics

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DOI: 10.5185/vpoam.2021.02137

Abstract

We present the construction and the application of biocompatible micro- and nano-structures that can be administered systemically and transport in a targeted and effective way drugs, small molecules, stem cells or immune system cells. These polymeric nano-systems represent a primary goal for the treatment of a wide family of neurological/systemic disorders, as well as tumors and/or acute injuries as natural, biocompatible, biodegradable and non-immunogenic building blocks, alginate and chitosan are been currently exploited. Ionotropic pre-gelation of the alginate core, followed by chitosan polyelectrolyte complexation, allow to encapsulate selected active molecules by means of physical entrapment and electrostatic interactions within sub-micron sized hydrogel vesicles. Here we present a microfluidic-assisted assembly method of nano- and micro-vesicles under sterile, closed environment and gas exchange adjustable conditions- a critical issue, when the cargo to be upload is very sensitive. Polymer/polymer and polymer/drug mass ratio relationship are crucial in order to attain the optimum in terms of shuttle size and cargo concentration. By modulating polymer reticulation conditions, it become possible to control drug loading efficiency as well as drug delivery dynamics. Recent results on the application of the vesicles for the encapsulation and delivery of Inhibin-A and Decorin secreted by Human Adult Renal Stem/Progenitor Cells for Renal tubular cell regeneration will be presented [**1**]. Moreover, combination of polymeric nano-systems with Superparamagnetic iron oxide nanoparticles (SPIONs) show a pH-responsive behaviour of great significance in controlled drug delivery and targeting of specific sites [**2**].

Finally, the impact of these polysaccharide sub-micron vesicles on Human Immune cells and the metabolic activity of cells embedded in the micro vesicles will be presented and discussed [**3**].

A different approach has been followed to biomimetic/bioinspired design and synthesis of structural and functional hybrid organic/inorganic SiO2-based nanostructures (NSs), which present many distinctive advantages over traditional chemical synthesis methods. The intriguing ability of diatom long chain polyamines (LCPAs) to rapidly induce precipitation of SiO2 spheres has motivated the *in vitro* one-pot synthesis of SiO2 particles. Therefore, the templating by amine-bearing molecules is seen as a successful biomimetic approach for the synthesis of SiO2-based hybrids under mild and environmentally friendly conditions for drug-delivery applications [**4**].

In conclusion, the design of novel hybrid architectures would represent a powerful approach for achieving advanced and smart materials with multiple functionalities and varied purposes.

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Biography of Presenting Author

Rosaria Rinaldi (H-index: 35 WOS, 40 Google Scholar) is Full Professor of Condensed Matter Physics at the Faculty of Sciences of the University of Salento, Italy, where she teaches Solid State Physics and Technology of Semiconductors and their Heterostructures, Physical Methodologies for Pharmaceutical and Industrial Biotechnology, and Nanobiotechnology and Nanobioelectronics. She is Coordinator of the Laboratory of "Interdisciplinary Applications of Exact Sciences" and Vice-Director of the Excellence University School ISUFI (Istituto Superiore Universitario di Formazione Interdisciplinare) of the University of Salento.
She is coordinator of the PhD school in Physics and Nanoscience, University of Salento. She is the director of the Regional Facility on "Nano-Biotechnologies for Diagnostics and Therapy NABIDIT". She is member of the Italian Ministry of University & Research (MIUR) Evaluation Board for the Strategic Research Plans of Public Research Centers. She has been Eleonore Trefftz Professor at Technical University Dresden Germany from May 2015 to Apr. 2016. She has been responsible of R&D joint labs with ST- Microelectronics ad Italian Institute of Technology (IIT, where she is research associate). On December 2005, she was Awarded by "Le Scienze" medal and the President (Carlo Azeglio Ciampi) of Italian Republic medal for the results achieved in the field of nano-biotechnology. On December 2007 Prof. Rinaldi was recognized as one of the most successful women in Southern Italy for leadership in Applied Science and industrial Innovation in the newspaper "il Sole 24 Ore": "Quando carriera fa rima con impresa" (When career rhymes with business). On November 2016 she won the ITWIIN (The Italian Association of Woman Inventors and Innovators)– prize for "High Education".

She authored chapters for eleven research monographs (published in Springer, Elsevier, Wiley, World Scientific) "Growth and characterization of selfassembled semiconductor macroatoms", "Molecular Electronics", "Nano-Bio Electronics", "Protein based nano-devices", "Amyloid fibrils: from nature to nanotechnology", "Nanotechnology for diagnostics and sensing: soft and advanced imaging/sensing approaches", "Biological Applications of LbL Multilayer Capsules: From Drug Delivery to Sensing.","Carnosine and Alzheimer's Disease-Related Fibril Formation", "Toxicity assessment in the Nanoparticle Era", "Nanotechnologies for Neurosciences"; "Nanoscale Molecular Automata: from Materials to Architectures". She edited an influential book "Nanobiolectronics for

electronics, biology and medicine"(Springer, 2009). Authored over 280 papers in peer reviewed international journals Awarded over 10 million EURO in grants from the Italian MIUR, EU, Regional Government in, last 10 years.

The research group of Prof. Rosaria Rinaldi operates in “Nanomedicine, Nanobioelectronics and Nanobiotechnology Laboratory”, which is a joint lab of IMM and of the Dept. of Mathematics and Physics of UNISALENTO, in Lecce. The group has more than 25 year of experience on the following research areas:

i) Nanolithographies, soft lithographies, and Surface functionalization; ii) new prototype of molecular and biomolecular electronic devices. Nanobiosensors, Lab-on-chip for analysis and diagnostics at the point of care; iii) Scanning probe microscopy and spectroscopy of single molecules, cells, and molecular layers and crystals, under different environment and at low temperature; iv) intelligent drug delivery and targeted therapy; v) design and bioengineering of polymeric scaffolds for tissue engineering and regenerative medicine; vi) Fluorescence, phosphorescence, Raman and micro-nano-fluorescence studies of biological species; and vii) technology of prototype hybrid devices. Molecular Quantum Cellular Automata; viii) investigation of the linear and non-linear optical properties of fluorescent molecules, polymers and nanocrystals.

Citation of Video Article

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