Smart Materials in Nanomedicine

Gianni Ciofani[1,2]

1 Politecnico di Torino, Department of Mechanical and Aerospace Engineering, Corso Duca degli Abruzzi 24, 10129 Torino, Italy
2 Istituto Italiano di Tecnologia, Center for Micro-BioRobotics @SSSA, Viale Rinaldo Piaggio 34, 56025 Pontedera (Pisa), Italy

gianni.ciofani@iit.it

Nanotechnology has enabled unprecedented control of the interactions between materials and biological entities, from the microscale down to the molecular level. For example, nanosurfaces and nanostructures have been used to mimic or interact with biological microenvironments, to support specific biological functions such as cell adhesion, mobility and differentiation, as well as tissue healing.
Recently, a new paradigm has been proposed for nanomedicine to exploit the intrinsic properties of nanomaterials as active devices rather than as passive structural units or carriers for medications. In this view, the nanomaterial itself is the active device that responds to external stimuli by modifying its intrinsic chemical and/or physical characteristics, so as to provide useful bio-stimulation and/or bio-signaling.
Our research approach falls into this latter, "active" category: we develop "smart" nanomaterials that change their structural/functional properties in response to specific external stimuli (electric or magnetic fields, electromagnetic radiation, ultrasound, *etc.*). Specifically, we develop multifunctional nanostructured materials that are pharmacologically active and that can be actuated by virtue of their magnetic, dielectric, optically active, or piezoelectric properties.
More in details, in this talk I will approach applications of smart nanomaterials such as piezoelectric barium titanate nanoparticles[1,2] and anti-oxidant cerium oxide nanoparticles[3], as active components for substrates and scaffolds for tissue engineering and regenerative medicine, with a special attention on stimulation of neuronal cells[4]. Moreover, a stimuli-responsive hybrid lipid/magnetic nanovector, for advanced theranostic applications, will be introduced[5].
This presentation will summarize our main results to date, and highlights the most promising examples that could have a practical translation into the clinical or technological realms.

Acknowledgments
This research is partially supported by the Italian Ministry of Health Grant Number RF-2011-02350464, and by the *Compagnia di San Paolo* Starting Grant Number 55_AI16GC01

1. Genchi G.G., [...], Ciofani G. Nanotechnology, 27(23): 232001 (2016)
2. Marino A., [...], Ciofani G. ACS Nano 8(11): 11869-11882 (2014)
3. Rocca A., [...], Ciofani G. Nanomedicine 11(7): 1725-1734 (2015)
4. Genchi G.G., [...], Ciofani G. Advanced Healthcare Materials, 5(14): 1808-1820 (2016)
5 Grillone A., [...], Ciofani G. Advanced Healthcare Materials 4(11): 1681-1690 (2015)