

Nanostructured Materials for the Environmental Control of Cell and Microorganism Growth

Enrico Traversa

Department of Chemical Science and Technology, University of Rome Tor Vergata, Rome 00133, Italy

Some of the most exciting findings reported in the last years are in the research field of the interaction between materials and biological matters, in particular when used in medical and clinical applications. The development of nanostructured materials has given a great pulse to these investigations. This because the most critical aspect to be studied is the interaction between the materials and the biological systems, which means their interface. Interfaces can be emphasized with the use of the nanostructured materials, where the surface/bulk ratio is significantly increased. The nano-bio interfaces can be exploited in numerous biomedical applications, where controlling the environment can positively or negatively affect the growth of cells and microorganisms. These properties can be tailored for applications where either the suppression of microorganism growth is needed, or to favour cell growth. Two examples of the opposite use of environmental control of cell and microorganism growth will be presented in this talk.

Using polymer-matrix nanocomposites with Cu nanoparticles is effective to stop the growth of fungi, and not only of bacteria. While bacteria are prokaryotes, fungi are eukaryotes, and therefore toxic agent for fungi are potentially harmful for humans too. Fungi can be harmful pathogen agents and copper has been used for decades as effective fungicidal. Health and safety issues can be faced by the development of active, controlled and intelligent food and beverage packaging. Free standing films or spinnable coatings, capable of a controlled release of antifungal species, can be extremely attractive materials to face this issue, provided that there will not be toxic for humans. Polymer based nanocomposite loading stabilized copper nanoparticles is proposed as a biostatic coating and systematic correlations between material properties and biological effects are established. The nanocomposites are able to release Cu species in a controlled manner and eventually to slow down or even inhibit the growth of living organisms, such as fungi and other pathogen microorganisms. The biostatic activity is correlated to the nanoparticles loading that controls the release of copper species.

The environmental control of cell growth was exploited to achieve the fabrication of myocardial cell sheets from mesenchymal stem cells, using nanostructured polymeric scaffolds. Tissue engineering and regenerative medicine offers potential for the treatment of many diseases and it appears extremely interesting in cardiology treatments. The growth of mesenchymal stem cells that easily differentiated into myocardial cells was facile on scaffolds made of PLLA. The growth was favoured on scaffolds with ordered structures, with preferential directions of cell growth mimicking natural paths.