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Editorial

Special Issue
Nano meets Bio

This special issue is associated with a Symposium on Nanostructured Biological Materials, held during the V Meeting of the Brazilian Materials Research Society (SBPMat) in October, 2006, in Florianópolis, Brazil. The symposium gathered over 150 scientists from various fields, including physicists, chemists, engineers and biologists, who addressed the manipulation and characterization of biological materials at the molecular level. With the multidisciplinary character of the symposium, contributions associated with the basic physicochemical properties of biomaterials and biomimetic systems were combined with examples of potential applications of nanostructured biological materials. Among the topics covered were included Nanostructured films containing biologically-relevant materials; Biomimetic systems; Nanostructured biosensors; Biomaterials for implants; Experimental techniques and theoretical methods for molecular-level characterization; Drug design and delivery; Biohybrid composites; Bioinspired nanodevices and innovative materials.

Many of the contributions presented as posters, in oral sessions or invited lectures were submitted to this special issue of Mat. Sci. Engineering C (MSEC), of which 15 were selected after a rigorous peer-review procedure that abided by the recommendations of MSEC for regular papers. Though in a relatively small number, the papers published in this issue already give a flavor of the variety of subjects covered in the Meeting.

A topic largely debated during the Meeting regarded the study of bioinspired nanosystems for biomedical applications (Section 1 of this issue). In particular Oliveira et al. reported on the immobilization of liposome formulation on glass and silicon wafer substrates, forming alternate layer-by-layer films with poly(amidoamine) dendrimers. The formation of liposome/dendrimer multilayers and their ability to interact with BSA were confirmed by Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD) and surface plasmon resonance (SPR). The aim of the work of Pohlmann et al. was to establish a quantitative correlation between the drug permeability and the polymer concentration in nanocapsules containing poly(ε-caprolactone) at different concentrations. Diffusion was proposed as the main mechanism of drug release and the drug relative permeability was found to decrease according to the increase in the polymer concentration following a simple power law.

Borsali et al. described a new route for the synthesis and manipulation of block copolymers exhibiting Annexin-A5 protein binding ability. Well-defined spherical micelles containing negatively charged phosphonic diacid groups at their hydrophilic periphery originate from the self-assembly of amphiphilic macromolecules in aqueous media. This approach allowed precise control over micellar dimensions and properties such as core radius (i.e., payload capacity), corona width, and density of phosphate groups at the micelle periphery. Iron oxide nanoparticles were synthesized and characterized by Haddad et al. for biomedical applications, correlating the nanoscale tunabilities in terms of size, structure, and magnetism. The nanoparticles were characterized by XRD measurements, small-angle X-ray scattering and transmission electron microscopy. Preliminary tests of incorporation of these nanoparticles in cells and their magnetic resonance image (MRI) were also carried out.

A second topic largely discussed at the Meeting focuses on the design of bioinspired nanodevices for electronics and sensing (Section 2 of this issue). Pasquarelli here presents a review article on the technology and applications of biochips. The ability to characterize biological structures and dynamic processes in real-time at the nanometric level, offers an extremely powerful tool for the comprehension of the elementary phenomena occurring in the single cell. Cell populations or even tissue slices can be investigated on a microelectrodes array, making it possible to better understand the behaviour of cellular ensembles of increasing complexity.

The third section of the issue is dedicated to the design of new biohybrid nanostructures based on nanoparticles, nanotubes or gels. Chitosan-coated iron oxide magnetic nanoparticles were investigated by Laranjeira and coworkers for future application in cancer therapy. The size distribution of coated and uncoated iron oxide nanoparticles was evaluated by laser diffraction analysis and magnetic image analysis, respectively. The prepared ferrofluids were tested in therapeutics applications, such as in hyperthermia treatment, with extremely promising results. Hydrated bacterial cellulose (BC) membranes obtained from cultures of *Acetobacter xylinum* were used in the preparation of silver nanoparticles containing cellulose membranes by Ribeiro et al. Scanning electron microscopy (SEM) images and XRD patterns both lead to the observation of spherical silver particles with mean diameter of

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8 nm well adsorbed onto the BC fibrils. In the contribution of Gamarra et al. the distribution in blood and liver and the elimination kinetics of a biocompatible magnetic fluid, based on dextran-coated Fe_3O_4 nanoparticles were investigated. The half-life of iron magnetic nanoparticles in blood and liver samples was measured using electron paramagnetic resonance (EPR) and X-ray fluorescence (XRF) techniques. Ramos et al. studied the influence of surfactant type and concentration on particle size, formulation yield and stability of the polyurethane nanoparticles synthesized by miniemulsion polymerization. Non-ionic surfactants were found to obtain monomodal particle size distribution, good yields (>85%) and zeta potential around to −24 mV.

The biocompatibility of multi-walled carbon nanotubes grown on titanium and silicon surfaces was verified by Oliveira Lobo et al. using mouse cells. The results show very high cell viability and many layers of cells adhered on the surface formed by nanotubes tips at films grown on silicon surfaces.

Gel preparations are an important tool for biomedical applications and the importance of structural characterization of these systems cannot be neglected. Mansur et al. use FTIR spectroscopy and synchrotron small-angle X-ray scattering to characterize poly(vinyl alcohol) (PVA) hydrogel chemically crosslinked with glutaraldehyde (GA). PVA-derived hydrogel with chemically modified network was found to be pH-sensitive, indicating a high potential to be used in drug delivery polymer system.

The last section of this special issue was dedicated to bio-hybrid nanocomposites. Rambo et al. presented porous, nano-fibrous bacterial cellulose (BC) membranes produced by the bacterium *Acetobacter xylinum*. In situ pore formation was attained through the use of pin templates with diameters varying from 60 to 300 μm composed of polystyrene (Φ=300 μm) or optical fibers (Φ=60 μm). Microstructure evaluation revealed that the film matrix is composed of long nanofibers isotropically distributed on its surface. Microporous membranes could be useful for applications in repairing tissues, which require high oxygenation rates or wound contracture delay.

The influence of the deposition parameters (polymer concentration, pH) on the morphology and electrical conductivity of polyaniline and sulfonated polystyrene self-assembled films was investigated by Braga et al. and evaluated by UV–Vis spectroscopy, optical and atomic force microscopy, and electrical resistance measurements.

Santos et al. describe the synthesis and characterization of calcium phosphate/collagen biocomposites doped with Zn^{2+} hydroxyapatite (HAP) and hydroxyapatite-βtricalcium phosphate. All samples were characterized by SEM, FTIR and XRD analysis. In addition, biocompatibility and cell viability were assessed by MTT assay (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-tetrazolium bromide) using osteoblast cell culture. The biocomposites presented a homogeneous aspect with the calcium phosphate particles aggregated to the collagen fibers and showed appropriate physical and biological properties creating biologically active scaffolds that may support bone growth.

Poly(methylmethacrylate)-based composites filled with $Ca_3(PO_4)_2$–SiO_2–MgO glass were prepared by Ferreira et al. The nature of the orthopedic implant surface affects the interaction between cells and subsequent bone formation. The bone/cement interface in cement-held prostheses is considered to be the main cause of fracture leading to implant revision. The in vitro bioactivity of the composites was assessed by determining the changes in surface morphology and composition, by XRD and scanning electron microscopy coupled with X-ray energy dispersive spectroscopy (SEM-EDS).

Taken all together, the contributions presented in this special issue depicted a vivid panorama of the scientific activity in the field and represent distinguished examples of the potentialities and richness that come from the interplay of so different disciplines, at the crossroad where engineering, physics, chemistry and biology mix together and ‘Nano meets Bio’.

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