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Peptide-based materials: from nanostructures to applications

This special issue originates from the Symposium C entitled 'Peptide-based materials: from nanostructures to applications', held during the 2010 Spring Conference of the European Materials Research Society (Strasbourg, June 5–11, 2010). The Symposium gathered more than 65 scientists, including physicists, chemists, engineers, and biologists, who addressed the manipulation and characterization of peptide-based materials at the nanoscale level. Due to the multidisciplinary character of the Symposium, contributions associated with the basic physicochemical properties of peptide-based materials were combined with examples of potential applications of nanostructured biological materials. Among the topics covered, peptide self-assembly, peptide nanostructures, peptide-based hybrid materials, and peptide conjugates were included. Two sessions were devoted to applications of peptide materials.

Many of the contributions, presented as invited lectures, oral or posters, were submitted to this special issue of the *Journal of Peptide Science*. Thirteen were selected after a rigorous peer-review procedure that abided by the recommendations for regular papers, and give a flavor of the variety of subjects covered in the meeting.

A topic largely debated during the symposium regarded the study of the mechanism of peptide self-assembly. Amalia Aggeli (University of Leeds, UK) reported on the formation of amphiphilic β-sheet peptide tapes by self-assembly of 9-mer and 7-mer *de novo* designed β-strand peptides. Both peptides undergo a transition from a monomer random coil to a self-assembled β-sheet tape upon increase of peptide concentration. Peptide fibrils were obtained by Chaudhary and Nagaraj (CSIR, Hyderabad, India) by self-assembly of short amyloid fragments, driven by aromatic interactions between the phenylalanine residues. The effect of the substitution of phenylalanine by tryptophan units on the aggregation propensity of the peptide fragments was also investigated. Orthogonal peptide pairs forming parallel coiled-coil heterodimers with high content α-helical structures were synthesized by Gradišara and Jeralaa (University of Ljubljana, Slovenia). Selectivity and specificity of the peptide–peptide pair interaction were achieved by suitable combinations of electrostatic and hydrophobic interaction motifs.

Peptide nanotubes (PnT) were identified at the meeting as one of the most interesting peptide nanostructures with important possible applications. Shunsaku Kimura *et al*. (Kyoto University, Japan) used amphiphilic helical peptides to form PnT of different diameter (70–200 nm) and length (200 nm to 30 μm). Longest nanotubes were obtained by tuning the hydrophobic mismatch between left- and right-handed helices. Deposition technology, basic physics, and nanotechnology applications of PnT were described in the seminal review of Rosenman *et al*. (Tel Aviv University, Israel). Interesting electronic and optical properties (piezoelectricity, second harmonic generation, ferroelectric polarization, etc.) related to quantum confinement effects were generated by the asymmetric structure of PnT.

Peptide-based hybrid materials were also extremely popular at the meeting. Carlos Aleman (Polytechnic of Barcelona, Spain) established a computational strategy to model, at the atomistic level, flexible molecules tethered to a metallic rigid surface. It was found that the peptide–surface interaction mainly affects the geometrical orientation of the side chains, without perturbing the predominantly populated bioactive conformation. The specific binding of peptides to films of synthetic polymers containing azobenzene groups was investigated by Serizawa *et al*. (University of Tokyo, Japan). The sequence Trp-His-Thr-Leu-Pro-Asn-Ala showed the highest binding affinity with high specificity for the *cis*-azobenzene conformation. Carbon nanotubes functionalized with cell adhesion peptides were proposed by Bianco *et al*. (CNRS, Strasbourg, France) as novel drug delivery systems and as advanced tools for the design of new-concept nerve 'bridges'. Immunogenic properties of the peptide–carbon nanotube conjugates were also assessed. Sandeep Verma *et al*. (IIT, Kanpur, India) described the synthesis and morphological characterization of a new glycopeptide. DNA encapsulation in self-assembled peptide superstructures was achieved by ultrasonication in the presence of plasmid DNA. Peptide–nucleic acid nanostructures were also investigated by Bechinger *et al*. (CNRS, Strasbourg, France), focusing on the capacity of these conjugates to overcome the cell membrane barriers for an efficient transfection activity.

Applications of peptides in materials science found deep interest at the meeting. Peptides capable of binding selectively to indium nitride semiconductors (InNis) were obtained by Gergely *et al*. (University of Montpellier II, France) by phage display technology. Peptide-functionalized InNis were shown to be promising platforms for developing optical and electrochemical biosensors. Photocurrent generation experiments on peptide-based self-assembled monolayers supported on gold electrodes were carried out by Venanzi *et al*. (University of Rome Tor Vergata, Italy). The role of antenna chromophores and the junction effects at the gold–peptide interface on the photocurrent efficiency were thoroughly investigated. Morelli *et al*. (University of Naples, Italy) synthesized nanoparticles from self-aggregating amphiphilic peptides containing octreotide units and Gd(III) peptide complexes. The presence of octreotide monomers exposed on the surface of the nanoparticles conferred them potential binding selectivity toward somatostatin receptors.

Scientific evolution has led to discipline divergence. Yet, at the same time, scientific advances have shown the merit of interdisciplinary collaborations and of the potential contribution of scientists from one field toward another. Peptide-based materials provide a great example; it is a relatively new field which has attained considerable attention due to their potential applications

in different areas, and it is also a field where scientists arising from very different disciplines can make major contribution. These features are clearly reflected by the contributions presented in this special issue, which depict 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.

We do hope that this special issue would represent a significant milestone in this rapidly growing field.

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