Editorial

It is my great privilege as Director of the *NATO Advanced Study Institute (ASI) on Polymer Based Systems on Tissue Engineering, Replacement and Regeneration*, held from 15th to 25th of October 2001 in Alvor, Algarve, Portugal, to introduce you to a selection of papers resulting from the original contributions presented by the ASI students.

Typically, as also in the present case, an ASI results in a state of the art book composed of invited chapters prepared by the ASI faculty. These books are, of course, very useful research and education tools. I hope the book, also to be published by Kluwer Press, can give the readers the same degree of satisfaction we experienced when preparing it for publication. Nevertheless, in NATO courses the ASI students also have the chance to present their original works as posters or in some cases as short oral presentations. During the course, and when looking at the quality of some of the works, we decided to propose to Prof. William Bonfield (also a lecturer at the ASI) the preparation of a special issue of *JMSMIM* containing a selection of the best works presented at the course. He and Kluwer welcomed the idea, and it was decided I should act as Guest Editor. After a careful reviewing process, we ended up with the papers contained in this special issue.

During the last century, and particularly in the last three decades, conventional materials technology resulted in clear improvements in the field of substitution medicine. The development of artificial hips and knees are only two examples of the enormous benefits this technology has had for patients. However, there are still no materials available that can adequately replace several functional tissues, such as bones or large bone segments. Therefore, despite the enormous benefits the contemporary technology has brought, the outer limits have been reached and new breakthroughs can only be expected from a novel hybrid technology that will reduce the shortcomings of the current material technology. Such a combined, biology driven approach is referred to as ''tissue engineering'', by which biological tissues are engineered through combining material technology and biotechnology. Tissue engineering thus involves the culture of living human cells usually in polymeric scaffold materials, *ex vivo*, and allows them to develop into a three-dimensional tissue. This will be the focus on biomaterials research and substitution medicine in the coming decades. It will also create the need for the education of new scientists and engineers that are also ''hybrid'' and can perform multidisciplinary research, combining materials and biotechnology.

Internationally, the combination of materials (namely polymer) technology and biotechnology is seen as the sector in which most major breakthroughs can be expected for medical devices in the coming future. Substantial gains are expected to be obtained both from a medical and economic standpoint as a result of this emerging technology. One of the main difficulties related with performing research in this area is the clearly multidisciplinary approach of the teams. A strong group working on tissue engineering and regeneration must combine the expertise of materials scientists, polymer chemists, engineers, chemists, biologists, biochemists, etc. The problem is not only to join the correct team but also to make people understand all the requirements needed from the polymer and biotechnology side, generating synergies on their daily activities.

The most important materials that are being used on the development of adequate materials for tissue engineering, replacement and regeneration are based on polymers and its composites reinforced with bioactive ceramics. In order to design adequate materials for these functions it is necessary: (1) to design polymers with the correct chemistry, producing new macromolecules, smart materials, using combinatory chemistry, etc.; (2) to understand the available choices among existing polymeric biomaterials that qualify for a certain specific application; (3) to use the possibility of local delivery of drugs/growth factors, hormones, etc.; (4) to induce tissue regeneration or a certain therapeutic effect, by using adequate carriers; (5) to process materials into adequate parts and porous scaffolds, using non-conventional techniques, and to maximize its mechanical properties in order that they can perform their function; (6) to design adequate scaffolds and to control their morphology, degradation and surface properties in order to optimize cell adhesion and differentiation; (7) to understand and study the principles of biocompatibility in order to design adequate systems and tailor their properties for the purposed applications; and finally (8) to look continuously for new materials that are ''more ideal'' from all these perspectives.

We decided to organize a *NATO Advanced Study Institute (ASI) on Polymer Based Systems on Tissue Engineering, Replacement and Regeneration*, when we realized that there was a clear need for a course that would address in an integrated way all the above topics. In fact, polymer-based systems are playing, and will play, a key role on tissue engineering, replacement and regeneration in the near future. This biologically driven materials science is believed to be one of the more appealing and funded research areas in the first decades of the twenty-first century. No course has addressed this topic before in such an integrated and ''forward looking'' perspective. An ASI seemed to be the best forum to educate and brainstorm on this area of such strategic importance.

Finally, I must say that, as most of you know, a course cannot be organized without the help of hard working people and support from several institutions. I would of course first of all like to thank the NATO Scientific Division for their support that made the course possible. I would also like to acknowledge the many contributions of my co-director and friend Danny Cohn. He was a great support whenever I needed it. The members of the scientific committee and several of the lectures made a lot of useful suggestions. We wish to thank all the invited speakers that made the course possible. But the course, and the program, were also made by the ASI students and their wonderful contributions. The best of these contributions lead to this special issue. The many reviewers involved on the refereeing process are also gratefully

acknowledged. University of Minho and the Department of Polymer Engineering that have supported me and my students in so many ways also deserve a word of appreciation. But I am especially grateful to my group, my colleagues, post-docs, PhD and MSc students. The outcome of this ASI was mainly the result of their hard work, dedication and ambition. They have put a great number of hours into this enterprise and realized that this was an important organization for all of us. I cannot refer to all the names herein, but if you find one of the members of the *3B's Research Group – Biomaterials, Biodegradables and Biomimetics* (that I have the pleasure of directing) in one of the meetings you attend, please just speak with her/him and you will see how fortunate I am for being able to advise such a wonderful group of young and bright researchers.

I hope you enjoy this special issue of *JMSMIM* as much as we have enjoyed preparing it.

Rui L. Reis
(Guest Editor)