



2nd Annual Conference and Expo on

Biomaterials

March 27-28, 2017 Madrid, Spain

Keynote Forum

Day I

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Orlando Auciello

University of Texas at Dallas, USA

Science and technology of multifunctional Ultrananocrystalline Diamond (UNCD™) coatings and applications to a new generation of implantable medical devices

New paradigms in the research and development of nanocarbon thin films are providing the bases for new physics, new materials science and chemistry, and their impact in a new generation of multifunctional biomedical devices. This talk will focus on discussing the science and technology of the new paradigm material named ultrananocrystalline diamond (UNCD™) in thin film form and integration into a new generation of medical devices and implants as described below: UNCD films co-developed and patented by O Auciello and colleagues are synthesized by novel microwave plasma chemical vapor deposition and hot filament chemical vapor deposition techniques using an Ar-rich/CH₄ chemistry that produces films with 2-5 nm grains. The fundamental science underlying the synthesis and properties of the UNCD films and applications to devices will be discussed. The UNCD films exhibit the lowest friction coefficient (0.02-0.04) compared with metals (≥ 0.5) currently used in many prostheses (e.g., hips, knees), electrically conductive UNCD coatings with nitrogen in grain boundaries can enable a new generation of neural electrodes, UNCD coatings are extremely biocompatible. Original Biomedical Implants (OBI-USA) and OBI-México, founded by Auciello and colleagues, are developing new generations of implantable medical devices based on the biocompatible UNCD coatings, namely: a) UNCD-coated silicon based microchip implantable inside the eye as a key component of the artificial retina to return partial vision blind by genetically-induced degeneration of photoreceptors; b) new generation of Li-ion batteries with $\geq 10x$ longer life and safer, using UNCD-based electrodes, membranes and inner wall battery case, enable next generation of defibrillator/pacemakers; c) new generation of implantable prostheses (e.g., dental implants, hips, knees) coated with UNCD eliminates failure of current metal-based implants due to synergistic mechanical wear/chemical corrosion by body fluids; d) UNCD-coated polymer with brain neurons tailored stiffness enables next generation less invasive electrodes for neural stimulation.

Biography

Orlando Auciello graduated with MS (1973) and PhD (1976) degrees in Physics from the Physics Institute "Dr. Balseiro" (Universidad Nacional de Cuyo-Argentina). He is an EE at the University of Córdoba, Argentina (1970), Researcher at the University of Toronto, Canada (1979-1984), Associate Professor at NCSU, USA (1985-1988), Distinguished Scientist at MCNC, USA (1988-1996), and Distinguished Argonne Fellow (1996-2012) at Argonne National Laboratory, USA. Currently, he is a Distinguished Chair at University of Texas at Dallas. He is directing basic and applied research programs on multifunctional oxide and novel Ultrananocrystalline Diamond (UNCD) thin films and their application in industrial, high-tech, and medical devices. The UNCD film technology is commercialized for industrial products by Advanced Diamond Technologies founded by him and his colleagues, (2003, profitable in 2014), and by Original Biomedical Implants (OBI-USA, 2013) and OBI-México (2016) for medical devices. He has edited 20 books and published about 500 articles in several fields, and holds 20 patents. He is an Associate Editor of *APL* and *Integrated Ferroelectrics*. He was the President of the Materials Research Society (2013) and a Fellow of AAAS and MRS.

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José Manuel Baena

Universidad de Granada, Spain

An improved biofabrication process to enhance cell survival and distribution in bioprinted scaffolds for cartilage regeneration

Tissue regeneration (TR) is currently one of the most challenging biotechnology unsolved problems. Tissue engineering (TE) is a multidisciplinary science that aims at solving the problems of TR. TE could solve pathologies and improve the quality of life of billions of people around the world suffering from tissue damages. New advances in stem cell (SC) research for the regeneration of tissue injuries have opened a new promising research field. However, research carried out nowadays with two-dimensional (2D) cell cultures do not provide the expected results, as 2D cultures do not mimic the 3D structure of a living tissue. Some of the commonly used polymers for cartilage regeneration are Poly-lactic acid (PLA) and its derivatives as Poly-L-lactic acid (PLLA), Poly(glycolic acids) (PGAs) and derivatives as Poly(lactic-co-glycolic acids) (PLGAs) and Poly caprolactone (PCL). All these materials can be printed using fused deposition modelling (FDM), a process in which a heated nozzle melts a thermoplastic filament and deposits it in a surface, drawing the outline and the internal filling of every layer. All these procedures uses melting temperatures that decrease viability and cell survival. Research groups around the world are focusing their efforts in finding low temperature printing thermoplastics or restricted geometries that avoid the contact of the thermoplastic and cells at a higher temperature than the physiologically viable. This mainly has 2 problems; new biomaterials need a long procedure of clearance before they can be used in clinical applications, and restrictions in geometries will limit the clinical application of 3D printing in TE. We have developed an enhanced printing process named Injection Volume Filling (IVF) to increase the viability and survival of the cells when working with high temperature thermoplastics without the limitation of the geometry. We have demonstrated the viability of the printing process using chondrocytes for cartilage regeneration. This development will accelerate the clinical uptake of the technology and overcome the current limitation when using thermoplastics as scaffolds.

Biography

José Manuel Baena, MSc is a Research Associate. He is the Founder of BRECA Health Care, pioneer in 3D printed custom made implants for orthopedic surgery, and RE-GEMAT 3D, the first Spanish bioprinting company. He is an expert in innovation, business development and internationalization. He is a Lecturer in some business schools, and is passionate about Biomedicine and Technology. In his free time, he also works as a Researcher at the Biopathology and Regenerative Medicine Institute (IBIMER).

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Raphael Gorodetsky

Hadassah Medical Center, Israel

Fibrin interactions with matrix dependent cells: Applications and mechanism

Based on the haptotactic (cell binding) properties of fibrin, we have conducted extensive studies on the cell binding properties of fibrinogen and developed new Fibrin-based dense dehydrothermally crosslinked biodegradable Microbeads (FMB) for culturing high density of cells in suspension for their implantation. The FMB can attract and carry high number of matrix dependent cells of different types and can be used to culture stromal cells of different origin including fibroblasts, placental cells, endothelial cells, smooth muscle cells, chondrocytes and osteoblasts as well as endothelial cells. We employed FMB to isolate mesenchymal pluripotent stem cells from bone marrow and cord blood to expand them *in vitro*, and to induce differentiation *in vitro* or to implant as progenitors cells to produce cartilage and bone tissues. In parallel studies on the mechanism of cell binding to fibrin we identified new family of ~20mer epitopes on fibrinogen that seem to be responsible for the selective haptotactic activity of fibrin based matrices. Synthetic peptides of these sequences on a matrix could be used to augment cell binding to matrices in tissue engineering. The family of the short haptotactic peptidic sequences, which were termed haptides were also investigated as potent cell penetrating agents following fibrinolysis, as well as non-immunogenic synthetic cell penetrating sequences. The possible systemic adverse effects of penetrating peptides as well as fibrin derived haptides were also investigated in parallel.

Biography

Raphael Gorodetsky is the Head of Laboratory of Biotechnology and Radiobiology at the Sharett Institute of Oncology, Hadassah Medical Center, affiliated to the Hebrew University in Jerusalem. He did his PhD at the Hebrew University in 1985 and Post-Doc at UCLA Medical Center. His earlier research interests were in developing new technologies for *in-vivo* analyses of trace elements. His interests include regenerative radiobiology and biomaterials for regenerative medicine with fibrin based biomaterials and interactions with different cell types. In applied research, he was the Founder and the Chief Scientist of Hapto Biotech, later merged to form Forticel International SA and was involved in numerous other ventures. Recently, he developed placental stromal cells based therapy for modulating regenerative processes and mitigation of radiation effects. Besides his numerous publications, he co-edited the book "Stem Cells Tissue Repair" (RSC publishers, Cambridge, UK). He is the Secretary of Israel Stem Cells Society (2014-2017) and is Member in different international societies.

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