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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 ≥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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