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Science and technology of multifunctional ultrananocrystalline diamond (UNCDTM) 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 (UNCDTM) 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/CH_4 chemistry that produces films with 2-5nm 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: 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; 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; 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 and UNCD-coated polymer with brain neurons tailored stiffness enables next generation less invasive electrodes for neural stimulation.

Speaker Biography

Orlando Auciello has graduated with MS (1973) and PhD (1976) degrees in Physics from the Physics Institute Dr. Balseiro (Universidad Nacional de Cuyo-Argentina) EE-University of Córdoba-Argentina (1970). He was a Researcher in the University of Toronto-Canada (1979-1984), Associate Professor-NCSU-USA (1985-1988), Distinguished Scientist-MCNC-USA (1988-1996) and a Distinguished Argonne Fellow (1996-2012)-Argonne National Laboratory-USA. Currently, he is the distinguished Chair in University of Texas-Dallas. He is directing basic and applied research programs on multifunctional oxide and novel ultrananocrystalline diamond (UNCD) thin films and application to 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, holds 20 patents. He is an Associate Editor of APL and Integrated Ferroelectrics, he was President of the Materials Research Society (2013) and the Fellow of AAAS and MRS.

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