Science and technology of multifunctional/low cost ultrananocrystalline diamond (UNCD™) coatings and applications to new generation of external and implantable medical devices

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Abstract

This talk will discuss the science and technology of the new paradigm material named ultrananocrystalline diamond (UNCD™) in film form and integration into new generation of external and implantable medical devices, described below:

UNCD films, developed/patented by Auciello and colleagues, are grown on many substrates by novel MPCVD and HFCVD technique, using Ar/CH_4 chemistry, producing films with 2-5 nm grains. 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 Nitrogen-doped N-UNCD coatings enable a new generation of corrosion resistant electrodes, UNCD coatings are the best biocompatible material, made of C atoms (element of life in the human DNA, cells, and molecules). OBI-USA/OBI-México are developing new generations of external and implantable medical devices based on UNCD coatings, namely: a) UNCD-coated silicon-microchip implantable inside the eye as key component of artificial retina, returning partial vision to people blind by genetically-induced degeneration of photoreceptors (Argus II device marketed by Second Sight in Europe and USA); b) new generation of Li-ion batteries with ≥ 10x longer life and safer, using UNCD-coated electrodes, membranes and inner wall battery case, enabling ≥ 15-20 years defibrillator/pacemakers and cell phones charged every 2-3 days; c) new generation of implantable prostheses (e.g., dental implants, hips, knees) coated with UNCD eliminates failure of current metal-implants due to mechanical wear / chemical corrosion by body fluids; d) N-UNCD-coated polymer with brain neurons tailored stiffness enables less invasive neural stimulation electrodes; e) UNCD-coated masks for trapping more efficiently COVID-19 virus, due to ≤ 20 nm pores vs micron size pores in current masks; f) Electrically conductive/water corrosion resistant Boron-doped UNCD-coated metal electrodes for water purification and cleaning of mask via generation of ozone, killing all virus, bacteria, and every pathogen on surfaces.

Image

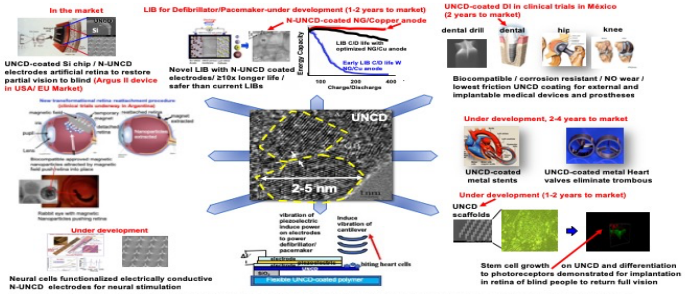


Figure 1. Unique Multifunctional Biocompatible / Body Fluids Corrosion Resistant Ultrananocrystalline Diamond (UNCD) Coating Enables New Generation of Superior Implantable Medical Devices and Prostheses over Current Failing Devices

Recent Publications

1. R. Zysler, A. Berra, P. Gurman, O. Auciello, M.J. Saravia (2016) Material for Medical Use Comprising Nanoparticles with Super-Paramagnetic Properties and Use in Surgery", US Patent # 9,427,354.
2. O Auciello, Y. Tzeng, C-P. Liu, C-K. Lin, Y-W Cheng (2015) Nanocrystalline-Diamond/Carbon; Nanocrystalline - Diamond / Si Composite Electrodes for Li-Based Batteries, US Patent # 9,196,905.
3. O. Auciello, P. Gurman, M. B. Guglielmotti, D.G. Olmedo, A. Berra and M.J. Saravia (2014) Biocompatible Ultrananocrystalline Diamond Coatings for Implantable Medical Devices". MRS Bulletin, 39 (07): 621 – 629.
4. O. Auciello and B. Shi (2010) Science / Technology of Bio-Inert Films as Hermetic-Encapsulating Coatings for Implantable Biomedical Devices: Application to Microchip in the Eye for Artificial Retina, Ch 3;Implantable Neural Prostheses 2: D. D. Zhou and E. Greenbaum (Eds). Springer: 63-70.
5. O. Auciello and A. V. Sumant (2010) Review of the science and technology of ultrananocrystalline diamond (UNCD™) films and application to multifunctional devices, Diam Rel. Mat., 19: 699–718.



Biography

Auciello graduated with MS (1973) and PhD (1976) degrees in Physics from the Institute "Dr. Balseiro" (Universidad Nacional de Cuyo-Argentina). EE-Universidad de Córdoba-Argentina (1970). Researcher-University of Toronto-Canada (1979-1984), Associate Professor-NCSU-USA (1985-1988), Distinguished Scientist-MCNC-USA (1988-1996), Distinguished Argonne Fellow (1996-2012)-Argonne National Laboratory-USA. Currently, Auciello is Distinguished Chair-University of Texas-Dallas. Auciello is directing basic and applied research programs on multifunctional oxide and novel ultrananocrystalline diamond (UNCD) 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 Auciello and colleagues, (2003, profitable in 2014), and by Original Biomedical Implants (OBI-USA, 2013) and OBI-México (2016) for medical devices. Auciello has edited 30 books and published about 550 articles in several fields, holds 20 patents, He is associate editor of APL and Integrated Ferroelectrics, He was President of the Materials Research Society (2013) Auciello is Fellow of AAAS and MRS.

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Notes/Comments: this is an abstract for a 45 min . Plenary Talk