

Ultrananocrystalline diamond (UNCD™) coatings for new generations high-tech/ medical devices/prostheses

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UT DALLAS Multifunctional Oxide and Unique Ultrananocrystalline Diamond (UNCD™) Coating Enable New Generation Industrial Products, High-Tech/ Medical Devices and Prostheses

ADVANCED DIAMOND TECHNOLOGIES, INC. UNCD™-Industrial Products in World Market

UNCD[®]-coated pump seals (20% operate energy cost savin) Market: US\$ 500 millions

UNCD[®]-coated bearings for Pharmaceutical Drug Mixers Market: US\$ 1.5 billion

UNCD NaDia AFM Probes[®] Market: US\$ 150 million

R&D done at Argonne (2000-2010) directed by Auciello, developed UNCD-coated Si chip implantable in human eye to restore partial vision to blind people

USA México

Revolutionary new retina reattachment (3 patients recovered full vision In clinical trials in Argentina)

Merck Millipore Nova Mixer with UNCD-coated bearing (Catalog #C10728)

Electrically conductive N-UNCD™ tips/corrosion resistant electrode array

Super-paramagnetic Nanoparticles injected in eye attracted by magnetic field push Retina back to eye

UNCD-coated magnet temporarily outside eye produces magnetic field

Novel Li-ion battery with electrical N-UNCD-coated anodes, ≥10x longer capacity energy life / safer than current LIBs N-UNCD-coated Ni/Cu anode

(Market ~ US\$ 50 billions)

HRTEM Image

Commercial LIBs Ni/Cu anodes

Charge/Discharge cycles

UNCD-coated metal prostheses (Markets: ~ US\$ 10-20 billions)

Dental implant hip knee stent heart valves

Implanted - 50 people (2018-present)-México to market in 2024-25

Under development

Electrolysis Water purification system with conductive/corrosion resistant B-doped B-UNCD-coated metal electrodes (Market ~ US\$ 80 billions)

Ozone kills viruses, bacteria, fungi, mold, pathogens, protozoa, cysts, algae, yeasts.

hybrid piezoelectric/UNCD biosensor

electrodes Anthra

SEM image:

piezo/UNCD MEMS cantilever

Embryonic stem cells grown on UNCD surface differentiated to photoreceptors

ULTRANANOCRYSTALLINE DIAMOND COATINGS for Next-Generation High-Tech and Medical Devices Edited by Orlando Auciello

This article provides a summary of materials science, materials integration strategies, materials properties, and design and development of new generations of industrial products, high-tech and external/implantable medical devices/prostheses, and treatment of medical conditions, based on the unique biocompatible Ultrananocrystalline Diamond (UNCD™) coating co-developed by Auciello and colleagues, and key oxide films and nanoparticles, to improve the quality of life of people worldwide

The target audience for this article includes undergraduate/graduate students, postdocs, scientists and engineers in Academia and Industry in different fields of science and technology, including materials scientists, mechanical engineers, bioengineers, applied physicists/chemists, medical device designers/manufacturers, and medical doctors/surgeons, who, by knowing more about biomaterials and devices they are implanting in people, may make better decisions when selecting a device based on the appropriate material for implantation.

Information for manufacturers on the revolutionary Ultrananocrystalline Diamond coating

This article also provides valuable information to manufacturers of medical implants, about the new revolutionary UNCD™ coating that can be grown directly on current bare metal-based implantable devices (e.g., dental implants, hips, knees, and more), eliminating failure due to synergistic mechanical/chemical (due to body fluids)-induced degradation. The information on the science/technology of UNCD coatings, for medical devices/prostheses, is also valuable for the public, for them to know that a new transformational biocompatible material named UNCD, in coating form, can produce new generation of implantable medical devices, prostheses, and artificial cells grown and differentiated on the UNCD's surface, the latter enabling new artificial biological treatments of degenerated human natural cells, such that UNCD-based biotechnologies provide revolutionary improvements in the way/quality of life of people worldwide.

Technologies already demonstrated and in an advanced and less advanced state of development are described briefly and shown in the Figure below, providing a summary of products already in the world market and under development for insertion into the world market, as described below in order of state of development:

Ultrananocrystalline Diamond-coated mechanical pump seals/bearings and Atomic Force Microscope tips, marketed worldwide since early 2000s by Advanced Diamond Technologies (ADT Inc.) (company founded by Auciello and colleagues, sold, in 2019, to large company (John Crane), now manufacturing products based on UNCD coatings).

Ultrananocrystalline Diamond films were demonstrated as hermetic/best biocompatible/bioinert coating for encapsulation of Si microchip ("Artificial Retina"), implantable on human eye's retina, to restore Partial Vision to people blinded by retinitis pigmentosa (10 years of R&D (2000-2010) by group of scientists, engineers, biologist, medical doctors, surgeons (four Universities, five National Laboratories, and a USA-Company (Second Sight)) resulted in the Argus II device (currently without the UNCD-coated Si chip, because needs FDA approval), implanted in hundreds of blind people in the USA and Europe, returning partial vision.

A new generation of Li-ion Batteries (LIB)

New generation of Li-ion Batteries (LIB) with order of magnitude longer stable capacity energy life and safer than current LIBs. The new LIBs are based on unique electrically conductive Nitrogen atoms grain boundary incorporated N-UNCD coating on current commercial anodes / cathodes, eliminating Li-corrosion. N-UNCD- based LIBs are under advanced state of development for new generation Defibrillator/Pacemaker/implantable battery powered medical devices, and cell phones and portable electronics.

Unique water purification system with water-corrosion resistant electrically conductive Boron-doped UNCD-coated metal electrodes, producing electrolysis-induced ozone molecules, killing all viruses/pathogens in water.

UNCD™-coated new generation of implantable prostheses: 1) UNCD- coated commercial metal dental implants (DIs) (50 patients implanted in Mexico (2018-present), demonstrated that these prostheses are the new revolution, with UNCD coating

eliminating chemical attack by oral fluids, which destroy ~15% of current Ti-alloys DIs inserted in people's mouth worldwide; 2) Other prostheses with UNCD coating under development include artificial metal hips/knees.

Novel integrated biocompatible super- paramagnetic oxide (Fe_2O_3 -approved by FDA-USA) nanoparticles injectable in human eye, attracted by magnetic field generated by external UNCD™-coated magnet, push detached retina back on inner wall of human eye, providing new transformational retina reattachment process, order of magnitude better/safer than current treatment injecting gas or oil bubbles in the eye (animal and initial clinical tests on humans, performed in Argentina by ophthalmologist surgeon Saravia, Auciello, and colleagues demonstrated the new treatment).

Super-hydrophobic UNCD™- coated polymer-based valves

Super-hydrophobic UNCD™-coated polymer-based valves have been demonstrated, providing order of magnitude better performance than current uncoated polymer valves, to pump out fluid from the inner eye with trabecular drainage tubes clogged (glaucoma condition-second cause of blindness).

Novel UNCD™-based scaffolds provide order of magnitude better surfaces for growing pluripotent stem cells and inducing electric-field-based differentiation into other human cells for developmental biology and biological treatment of human medical conditions.

Integrated multifunctional piezoelectric oxides or nitrides/UNCD™ films on tailored substrates to produce a new generation of biomedical MEMS Energy Generation, Drug Delivery and Sensor Devices.

The Figure above shows a summary of technologies/devices based on the revolutionary UNCD film technology.

Please Note: This is a Commercial Profile



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