Argonne's Ultrananocrystalline Diamond Intellectual Property				
Title	**Benefits**	**U.S. Patent/Patent App. No.**	**Co-Owned**	**ANL Invention**
Simple Method to Fabricate Nano-Porous Diamond Membranes	• Biocompatible for skin grafting, as well as for water purification applications	8,673,164 Issued March 18, 2014		IN-11-001
Ultrananocrystalline diamond films with optimized dielectric properties for advanced RF MEMS capacitive switches	• A specialized radio frequency (RF) micro-electromechanical system (MEMS) switch that promises enhanced capabilities for next-generation military and commercial communication systems • Robust and reliable with extremely low power consumption; prevents overcharge and improves safety • CMOS compatible	8,354,290 Issued January 15, 2013		IN-09-070
UNCD Films with optimized dielectric properties for advanced RF MEMS capacitive switches	• A specialized radio frequency (RF) micro-electromechanical system (MEMS) switch that promises enhanced capabilities for next-generation military and commercial communication systems • Robust and reliable with extremely low power consumption; prevents overcharge and improves safety • CMOS compatible	9,269,519 Issued Feb. 23, 2016		IN-09- 070C
Direct Synthesis of Reduced Graphene Oxide Films on Dielectric Substrates	• Optically transparent, CVD deposition of reduced graphene oxide film directly on the glass substrate • Wafer-scale synthesis in few mins • Pin-hole free deposition • Moderate sheet resistance at lower thickness • High thermal conductivity than Tin Oxide	Patent application filed 14/711,335 on May 13, 2015		IN-14-110

RF MEMS Capacitive Switches With High Reliability	• A specialized radio frequency (RF) micro-electromechanical system (MEMS) switch that promises enhanced capabilities for next-generation military and commercial communication systems • Robust and reliable with extremely low power consumption; prevents overcharge and improves safety • CMOS Compatible	8,525,185, issued September 3, 2013	Yes	IN-09-053
Graphene Layer Formation at Low Temperature on a Metal and Carbon Based Substrate	• Direct growth of graphene on insulating substrate at wafer-scale • Order of magnitude increase in breakdown current density reaching up to one thousand times improvement over conventional metal based interconnects	8,906,772 Issued December 9, 2014		IN-11-055
Graphene Layer Formation at Low Temperature on a Metal and Carbon Based Substrate	• Direct growth of graphene on insulating substrate at wafer-scale • Order of magnitude increase in breakdown current density reaching up to one thousand times improvement over conventional metal based interconnects	U.S. Patent No. 9,875,894 issued Jan. 23, 2018		IN-11- 055C
Graphene Layer Formation on a Carbon Based Substrate	• Direct growth of graphene on insulating substrate at wafer-scale • Order of magnitude increase in breakdown current density reaching up to one thousand times improvement over conventional metal based interconnects	8,652,946, issued February 18, 2014	Yes	IN-12-024

Graphene Layer Formation on a Carbon Based Substrate	• Direct growth of graphene on insulating substrate at wafer-scale • Order of magnitude increase in breakdown current density reaching up to one thousand times improvement over conventional metal based interconnects	9,202,684, issued December 1, 2015	Yes	IN-11-055B
All 2D High Mobility, Flexible, Transparent, Thinnest Thin Transistor	• Flexible, transparent high mobility thin film transistor for flat panel display • 10 atomic layers thick • On/off ratio is as good as current commercial thin-film transistors	9,548,394 Issued January 17, 2017		IN-14-013
Giant PiezoResisitivity in Boron Doped Diamond Nanowire	• Increased sensitivity to applied strain for tactile sensing • More environmentally stable than conventional silicon-based piezoresistive sensors	9,441,940 Issued September 13, 2016 9,696, 222 issued July 4th, 2017		IN-14-016 IN-14-016b
Nanowire and microwire fabrication technique and product	• Simple electrochemical method to mass-produce metal nanowires	9,903,033 issued February 17, 2018	Yes	IN-12-087
Method To Deposit Optically Transparent And Scratch Resistant Nanocrystalline Diamond Glass At Low Temperatures	• Optically transparent, scratch resistant ultrathin film of diamond on glass for protective applications	U.S. Patent No. 9,741,561 issued Aug. 22, 2017 Divisional of above, filed as U.S. Patent App. No. 15/676,895 on Aug. 14, 2017	Yes	IN-14-006 & IN-14-006b

Semiconductor Devices Fabrication Based On Optically Transparent, Low Temperature Nanocrystalline Diamond On Glass, Quartz, And Sapphire	• Transparent semiconductor devices with high thermal conductivity	(filed with ANL-IN-14-006, above)	Yes	IN-14-007
Direct Integration Of Low Temperature Diamond With Semiconductor Materials For Efficient Thermal Management	• Thermal management of semiconductor devices	filed with ANL-IN-14-006, above)	Yes	IN-14-010
Method to Fabricate Portable Electron Source Based on Nitrogen Incorporated Ultrananocrystalline Diamond (N-UNCD)	• Prototype based on nitrogen incorporated ultrananocrystalline diamond film • Emission current densities of the order of 6mA/cm2 could be obtained at electric fields as low as 10 V/lm to 20V/lm	9,299,526, issued March 29, 2016	Yes	IN-14-019
Preparation of Carbon-Based Electrodes with High Thermal Conductivity for Battery Applications	• Unique combination of diamond nanoparticles and other carbon materials Improves the ability to remove heat efficiently from the battery system	9,991, 512 issued June 5, 2018	Yes	IN-13-078
Method to Fabricate Low-Stress N-UNCD Suitable for the Fabrication of MEMS/NEMS Devices	• Excellent chemical, mechanical and electrical properties, low intrinsic stress gradient Could be applicable in many fields, including bio-medicine, optics, and sensors and MEMS actuators for space applications	9,475,690, issued October 25, 2016	Yes	IN-14-008

Fabrication of Robust, Harsh Environment Compatible MEMS/NEMS Actuators Based on Electrically Conducting Diamond Films	• Excellent chemical, mechanical and electrical properties, low intrinsic stress gradient • Could be applicable in many fields, including bio-medicine, optics, and sensors and actuators for space applications	(filed with ANL-IN- 14-008, immediately above)	Yes	IN-14-009
Nitrogen Incorporated UltraNanoCrystalline Diamond As a Robust Electrical Contact to Diamond	• Efficient x-ray position detector for synchrotron applications	9,484,474, issued November 1, 2016;	Yes	IN-12-098
Ultra-nano Crystalline Diamond Contacts for Diamond Electronic Devices	• Efficient x-ray position detector for synchrotron applications	9,842, 958 issued December 12, 2017	Yes	IN-12- 098B
Fabrication of P-N Junction Device Through Diamond/2D Materials Heterojunction	• Efficient, p-n junction diodes for power electronics and rectification applications	10,186,584 issued on January 22, 2019		IN-15-097
Planer field emitters and high efficiency photocathodes based on ultrananocrystalline diamond	• Prototype planer filed emission based electron source for RF injectors in accelerators • At surface gradients 45–65 MV/m, peak currents of 1–80mA were achieved. • Good operation at moderate high vacuum (10-6 Torr)	9,418,814 issued Aug. 16, 2016	Yes	IN-14-106

1 Argonne filed ANL-IN-09-070B as U.S. Patent Application No. 13/708,401 on Dec. 7, 2012, claiming priority to ANL-IN-09-070. Argonne then filed ANL-IN-09-070C on June 5, 2015 as U.S. Patent App. No. 14/731,830 as continuation application of ANL-IN-09-070B, and further claiming priority to ANL-IN-09-070. Argonne subsequently abandoned ANL-IN-09-070B in favor of ANL-IN-09-070C.
2 Final office action rejection dated Jan. 2, 2019.

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