AKHAN Semiconductor
Patent Portfolio Acquisition Opportunity

17 Families, 68 Active Assets

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More information is available upon request and under NDA.
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Executive Summary

- RZV has been retained to monetize a pioneering patent portfolio from AKHAN Semiconductor, an IL-based company that specialized in diamond semiconductor materials and devices.
- Founded in 2012, AKHAN raised $30M+ to develop and patent technology related to synthetic super hard diamond coatings and substrates for a wide range of applications including smartphones, watches and tablets, optics, semiconductor manufacturing equipment, and high-performance semiconductors. The company also developed and patented diamond-coating technology to enable the world's most durable device screens.
- AKHAN ceased operations in June 2024 and is soliciting bids to dispose of its assets.
- Companies that may have an interest in the assets include AMD, Apple, Applied Materials, ASML, BOE, Corning, DIAMFAB, Diamond Foundry, Eldor, Hinduja, Honda, Honeywell, HP, Intel, Lockheed Martin, Lam Research, LUSIX, Morgan Advanced Materials, NeoCoat, Northrop Grumman, NXP, OPPO, Qualcomm, Raytheon, Samsung, Seagate, Seki Diamond Systems, Sumitomo Electric, Tesla, Texas Instruments, Toshiba, TSMC, Universal Display, VIS, and Xiaomi, among many others.

Portfolio:
17 Patent Families
22 US Patents
15 International Patents
Various trademarks
Encumbrances:
Information available under NDA
Price:
Consistent with market prices
Deal Structure:
Outright purchase
Deadlines:
All offers will be considered upon receipt

Key Granted / Allowed Patents

Reference	US Patent(s)	Title
AKHN-01202	US17/900464*	Thin Film Diamond Coating System And Method
AKHN-00804	US11784048B2	Diamond semiconductor system and method
AKHN-01004	US11107684B2	Diamond semiconductor system and method
AKHN-01302	US11552276B2	Multilayer diamond display system and method
AKHN-01800	US11656404B2	Monolithically integrated waveguide sensors on diamond display glass system and method.
AKHN-01400	US10725214B2	Diamond broad band mirror system and method
AKHN-01600	US11572621B2	Protective diamond coating system and method
AKHN-00901	US8933462B2	Method of fabricating diamond semiconductor and diamond semiconductor formed according to the method
AKHN-01700	US12031987B2	System and method for transistor pathogen detector
AKHN-01104	US11675110B2	Diamond coated antireflective window system and method

*Reissue of US10760157B2

Key Patent – US17/900,464* (AKHN-01202)

Title:	Thin film diamond coating system and method
Priority Date:	9 August 2016
Est. Expiration:	3 December 2037
PTA	116 days
Abstract:	Disclosed herein is a transparent glass system that includes an optical grade silicon substrate, and a nanocrystalline diamond film on the silicon substrate, the diamond film deposited using a chemical vapor deposition system having a reactor in which methane, hydrogen and argon source gases are added. Further disclosed is a method of fabricating transparent glass that includes the steps of seeding an optical grade silicon substrate and forming a nanocrystalline diamond film on the silicon substrate using a chemical vapor deposition system having a reactor in which methane, hydrogen and argon source gases are added.
Family Members:	US17/900,534

*Reissue of US10760157B2, granted September 1, 2022. Notice of allowance received September 5, 2024.

1. A transparent display comprising:
a glass substrate; and
a nanocrystalline diamond film formed on the glass substrate, wherein the nanocrystalline diamond film comprises a thickness from about 102 nm to about one micrometer;
wherein transmission of light through the glass substrate and the nanocrystalline diamond film is such that:
at least 88% of light comprising a wavelength of 550 nm passes through the transparent display;
less than 80% of light comprising a wavelength between 350 nm and 450 nm passes through the transparent display; and
less than 80% of light comprising a wavelength between 750 nm and 850 nm passes through the transparent display.

Key Patent – US11784048B2 (AKHN-00804)

Title:	Diamond Semiconductor System and Method
Priority Date:	30 July 2011
Est. Expiration:	14 October 2031
PTA	0 days
Abstract:	Disclosed herein is a new and improved system and method for fabricating diamond semiconductors. The system may include a diamond malarial having n-type donor atoms and a diamond lattice, wherein 0.16% of the donor atoms contribute conduction electrons with mobility greater than 770 cm2/Vs to the diamond lattice at 100 kPa and 300K. The method of fabricating diamond semiconductors may include the steps of selecting a diamond material having a diamond lattice; introducing a minimal amount of acceptor dopant atoms to the diamond lattice to create ion tracks; introducing substitutional dopant atoms to the diamond lattice through the ion tracks; and annealing the diamond lattice.
Family Members:	Granted patents: CN103717791B; KR102195950B1; KR102007051B1; EP2737112B1*; JP6195831B2; JP6580644B2; JP6898400B2; JP7443288B2; TWI659458B; TWI557776B Pending patents: US18/467,208; CN114420747A

*UK, DE

1. A method comprising:
fabricating a diamond semiconductor that includes a carrier concentration to activate and participate in conduction at room temperature and incudes an electron mobility at the room temperature, including:
selecting a diamond material having a diamond lattice, forming a diamond layer on a silicon dioxide layer;
introducing a first concentration of acceptor dopant atoms to the diamond lattice to create a plurality of dopant pathways;
introducing a second concentration of substitutional dopant atoms to the diamond lattice through the plurality dopant pathways, the substitutional dopant atoms being larger than the acceptor dopant atoms, the second concentration being higher that the first concentration; and
annealing the diamond lattice to remove the plurality of dopant pathways;
wherein the introduction of the acceptor dopant atoms does not create more than 1022/cm3 of vacancies in the diamond layer.

Key Patent – US11107684B2 (AKHN-01004)

Title:	Diamond semiconductor system and method
Priority Date:	6 January 2012
Est. Expiration:	6 January 2033
PTA	0 days
Abstract:	Disclosed herein is a new and improved system and method for fabricating monolithically integrated diamond semiconductor. The method may include the steps of seeding the surface of a substrate material, forming a diamond layer upon the surface of the substrate material; and forming a semiconductor layer within the diamond layer, wherein the diamond semiconductor of the semiconductor layer has n-type donor atoms and a diamond lattice, wherein the donor atoms contribute conduction electrons with mobility greater than 770 cm2/Vs to the diamond lattice at 100 kPa and 300K, and Wherein the n-type donor atoms are introduced to the lattice through ion tracks.
Family Members:	Granted patents: US10546749B2; US11837472B2; TWI672795B; TWI615943B; TWI711153B Pending patent: US18/498,756

1. A method of fabricating a monolithically integrated diamond semiconductor, the method including the steps of:
seeding the surface of a substrate material;
forming a diamond layer upon the surface of the substrate material; and
forming a semiconductor layer within the diamond layer,
wherein the semiconductor layer has n-type donor atoms and a diamond lattice, wherein the n-type donor atoms are introduced to the lattice through ion tracks, wherein the ion track are created using p-type acceptor dopant atoms.

Key Patent – US11552276B2 (AKHN-01302)

Title:	Multilayer diamond display system and method
Priority Date:	3 December 2016
Est. Expiration:	23 February 2038
PTA	81 days
Abstract:	Disclosed herein is a transparent glass system that includes an optical grade silicon substrate, a transparent substrate layer; a titanium dioxide transparent layer, the transparent layer having an index of refraction of 2.35 or greater; and a polycrystalline diamond layer, wherein the transparent layer is between the substrate layer and the polycrystalline diamond layer.
Family Members:	Granted patents: US10224514B2; US10897028B2 Pending patent: US17/990,368

1. A multilayer diamond display system, comprising:
a chassis layer;
an organic light emitting diode layer;
a capacitive touch layer; and
a diamond composite exterior lens, including:
a fused silica layer;
a crystalline diamond layer; and
a titanium oxide transparent layer between the fused silica layer and the crystalline diamond layer.

6. A multilayer diamond display system, comprising:
an organic light emitting diode layer;
a capacitive touch layer; and
a diamond composite exterior lens, including:
a fused silica layer;
a crystalline diamond layer; and
a titanium oxide transparent layer between the fused silica layer and the crystalline diamond layer.

Key Patent – US11656404B2 (AKHN-01800)

Title:	Monolithically integrated waveguide sensors on diamond display glass system and method
Priority Date:	29 December 2020
Est. Expiration:	17 December 2041
PTA	0 days
Abstract:	A transparent display includes a display including a transparent substrate and a patterned diamond layer formed on the transparent substrate to at least in part define a diamond waveguide. At least two electronic devices can be connected by the diamond waveguide, and can include a sensor, a transducer, or electronic circuitry, including communication, control, or data processing electronic circuitry.
Family Members:	Granted patents: US11921319B2 Pending patents: US18/441,699; CN116686033A; KR20230146512A; JP2024507280A; EP4272253A1; TW110147251

1. A transparent display, comprising:
a display including a transparent substrate and a patterned diamond layer formed on the transparent substrate to at least in part define a diamond waveguide; and
at least two electronic devices connected by the diamond waveguide.

8. A method for forming a transparent display incorporating a waveguide, comprising providing a transparent substrate;
forming a diamond film including polycrystalline and/or nanocrystalline diamond on the transparent substrate, and
patterning optical waveguide structures in the diamond film by etching, with the optical waveguide structures able to interconnect least two electronic devices.

Key Patent – US10725214B2 (AKHN-01400)

Title:	Diamond broad band mirror system and method
Priority Date:	8 February 2017
Est. Expiration:	2 February 2038
PTA	0 days
Abstract:	A broad band mirror system and method, wherein the system includes a mechanical substrate layer, a reflective metal layer on the mechanical substrate level, and a diamond layer, and the method includes the steps of selecting a sacrificial substrate layer, depositing a diamond layer on the substrate layer, smoothing a first surface of the diamond layer, depositing a reflective metal layer on the diamond layer, bonding a mechanical substrate to the diamond layer, removing the sacrificial substrate level, and smoothing a second diamond surface.
Family Members:	n/a

1. A broad band mirror system, comprising:
a mechanical substrate layer,
a reflective metal layer on the mechanical substrate layer,
at least one layer of Indium Tin Oxide; and
a diamond layer on the reflective metal layer.

7. A method of fabricating a broad band mirror, including the steps of:
selecting sacrificial substrate layer,
depositing a diamond layer on the substrate layer,
smoothing a surface of the diamond layer,
depositing a reflective metal layer on the diamond layer,
bonding a mechanical substrate to the diamond layer,
removing the sacrificial substrate layer; and
smoothing a second diamond surface after removal of the sacrificial substrate layer.

Key Patent – US11572621B2 (AKHN-01600)

Title:	Protective diamond coating system and method
Priority Date:	24 September 2019
Est. Expiration:	14 May 2041
PTA	232 days
Abstract:	Disclosed herein is system and method for protective diamond coatings. The method may include the steps of cleaning and seeding a substrate, depositing a crystalline diamond layer on the substrate, etching the substrate; and attaching the substrate to protected matter. The crystalline diamond layer may reflect at least 28 percent of electromagnetic energy in a beam having a bandwidth of 800 nanometer to 1 micrometer.
Family Members:	US18/099,430

1. A method of fabricating a diamond protective coating structure comprising:
cleaning and seeding a substrate;
depositing a crystalline diamond layer on the substrate;
etching the substrate; and
attaching the substrate to protected matter,
wherein the crystalline diamond layer reduces the impact of at least 28 percent of electromagnetic energy in a beam having a bandwidth of 800 nanometer to 1 micrometer.

Key Patent – US8933462B2 (AKHN-00901)

Title:	Method of fabricating diamond semiconductor and diamond semiconductor formed according to the method
Priority Date:	21 December 2011
Est. Expiration:	21 February 2033
PTA	62 days
Abstract:	Disclosed herein is a new and improved system and method for fabricating diamond semiconductors. The method may include the steps of selecting a diamond semiconductor material having a surface, exposing the surface to a source gas in an etching chamber, forming a carbide interface contact layer on the surface; and forming a metal layer on the interface layer.
Family Members:	US11043382B2; US11605541B2; US11915934B2; US18/418,976

1. A method of fabricating diamond semiconductor, the method including the steps of:
selecting a diamond semiconductor material having a surface;
exposing the surface to a source gas in an etching chamber;
forming a carbide interface contact layer on the surface; and
forming a metal layer on the carbide interface contact layer.

Key Patent – US12031987B2 (AKHN-01700)

Title:	System and method for transistor pathogen detector
Priority Date:	17 April 2020
Est. Expiration:	25 October 2042
PTA	554 days
Abstract:	Disclosed herein is a system and method for transistor pathogen virus detector in which one embodiment may include a substrate layer, a silicon dioxide layer on the substrate layer, a nanocrystalline diamond layer on the silicon dioxide layer, a graphene oxide layer on the nanocrystalline diamond layer, fluorinated graphene oxide portions; and a linker layer, the linker layer including a plurality of pathogen receptors.
Family Members:	US18/734,733

1. A transistor pathogen detector, comprising:
A substrate layer,
a silicon dioxide layer on the substrate layer,
a nanocrystalline diamond layer on the silicon dioxide layer,
a graphene oxide layer on the nanocrystalline diamond layer,
fluorinated graphene oxide portions; and
a linker layer, the linker layer including a plurality of pathogen receptors, wherein the transistor pathogen detector functions as a biosensor field effect transistor.

8. A method of fabricating a pathogen detector, including the steps of:
selecting a substrate;
forming a silicon dioxide layer upon the substrate;
forming a nanocrystalline diamond layer on the silicon dioxide layer;
forming a graphene oxide layer on the nanocrystalline diamond layer;
converting at least a portion of the graphene oxide layer to fluorinated graphene oxide; and
forming a linker layer on at least a portion of the fluorinated graphene oxide layer; and
binding a pathogen receptor to the linker layer, wherein the pathogen detector functions as a biosensor field effect transistor.

Key Patent – US11675110B2 (AKHN-01104)

Title:	Diamond coated antireflective window system and method
Priority Date:	1 March 2016
Est. Expiration:	23 June 2037
PTA	114 days
Abstract:	A system and method for diamond based multilayer antireflective coating for optical windows are provided. An antireflective coatings for optical windows may include an optical grade silicon substrate, a first polycrystalline diamond film on the silicon substrate, a germanium film on the first polycrystalline diamond film, a fused silica film on the germanium film; and a second polycrystalline diamond film on the fused silica film. A method of fabricating a diamond based multilayer antireflective coating may include the steps of cleaning and seeding an optical substrate, forming a first diamond layer on the optical substrate, forming a germanium layer on the first diamond layer, forming a fused silica layer on the germanium layer, cleaning and seeding the germanium layer, and forming a second diamond layer on the germanium layer.
Family Members:	US10422928B2; US11112539B2; US12061313B2

1. An antireflective coating for an optical substrate, comprising: a first polycrystalline diamond film on the optical substrate; a high refractive index film with an index of refraction greater than 3.4 on the first polycrystalline diamond film; a silicon containing film on the high refractive index film with an index of refraction greater than 3.4; and a second polycrystalline diamond film on the silicon containing film.

Key Applications

Reference	US Application(s)	Title
AKHN-00401 AKHN-00402	US17/869491 US17/975027	Diamond Structures For Tooling

Key Pending Patent – US17/869,491 (AKHN-00401)

Title:	Diamond Structures For Tooling
Priority Date:	20 July 2021
Est. Expiration:	n/a
PTA	n/a
Abstract:	A tool such as a wafer handler or wafer chuck can include a surface having at least one protrusion. A diamond coating is formed from diamond grains sized so that 90% of the grains are between 200 and 300 nanometers, with the diamond coating being deposited on the surface at a temperature below 500 degrees Celsius over the at least one protrusion. Dopants can be used to provide electrical conductivity needed for electrostatic wafer chuck.
Family Members:	Pending patents: US17/975,027; TW202321496A; JP2024529372A; EP4373991A1; KR20240035828A; CN117642524A

1. A tool, comprising:
a surface having at least one protrusion; and
a diamond coating formed from diamond grains sized so that 90% of the diamond grains are sized between 200 and 300 nanometers, with the diamond coating being deposited on the surface at a temperature below 500 degrees Celsius over the at least one protrusion.

11. A method for diamond coating a tool, comprising
providing a tool having a surface with at least one protrusion; and
forming a diamond coating on the surface over the at least one protrusion, with the diamond coating being formed from diamond grains sized so that 90% of the grains are between 200 and 300 nanometers, and with the diamond coating being deposited on the surface at a temperature below 600 degrees Celsius over the at least one protrusion.

Key Pending Patent – US17/975,027 (AKHN-00402)

Title:	Diamond Structures For Tooling
Priority Date:	20 July 2021
Est. Expiration:	n/a
PTA	n/a
Abstract:	A substrate for a tool including at least one sidewall includes at least one diamond layer. The diamond layer has a thickness between 10 nanometers and 1000 nanometers and is formed from diamond grains sized to be 50% or less of diamond layer thickness, with the diamond coating being deposited on the surface of the substrate over the at least one sidewall.
Family Members:	Pending patents: US17/869,491; TW202321496A; JP2024529372A; EP4373991A1; KR20240035828A; CN117642524A

1. A structure, comprising:
a substrate having a surface including at least one sidewall; and
a diamond layer having a thickness between 10 nanometers and 1000 nanometers and formed from diamond grains sized to be 50% or less of diamond layer thickness, with the diamond coating being deposited on the surface of the substrate over the at least one sidewall.

13. A method for depositing a layer, comprising:
providing a substrate having a surface including at least one sidewall; and
depositing a diamond layer having a thickness between 10 nanometers and 1000 nanometers and formed from diamond grains sized to be 50% or less of diamond layer thickness, with the diamond coating being deposited on the surface of the substrate over the at least one sidewall.

Key Pending Patent – 17/975,027 (AKHN-00402)

25. A wafer tooling structure, comprising:
wafer tooling including a substrate having a surface including at least one sidewall; and
a diamond layer having a thickness between 10 nanometers and 1000 nanometers and formed from diamond grains sized to be 50% or less of diamond layer thickness, with the diamond coating being deposited on the surface of the substrate over the at least one sidewall.

37. A method for depositing a layer on wafer tooling, comprising:
providing a wafer tool including a substrate having a surface that further includes at least one sidewall; and
depositing a diamond layer having a thickness between 10 nanometers and 1000 nanometers and formed from diamond grains sized to be 50% or less of diamond layer thickness, with the diamond coating being deposited on the surface of the substrate over the at least one sidewall.

Thanks!

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