**Richard Ernest Demaray, Ph.D.**
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Ernest is a Chemical Physicist, inventor and entrepreneur with a specialty in energy transfer and storage. He raised a family and put himself through school as a machinist and instrument maker, which provided hands on opportunity at each stage of his career to fabricate devices based on original invention. Ernest has five commercial portfolios of allowed patents as well as granted patents assigned to General Electric and First Solar as well as Morgan Ceramic. His last portfolio for defect free amorphous dielectric thin films is assigned to Demaray LLC and in production under licenses to STMicro and Apple. It can be found along with applications information at www.edemaray.com where it is available for commercial license.

As an undergraduate chemist at Cal. State Hayward, Ernest began work in college and university machine shops where he helped design and built a vacuum cryostat to study the UV photoconductivity of bovine rhodopsin in n-pentane ice one summer on his own time. It was used by later graduate students successfully.

His thesis at U.C. Santa Cruz with Prof. Roger Anderson ('77) utilized cross supersonic molecular and atomic beams which he designed critical aspects. With this apparatus and with NSF funding, he demonstrated "adiabatic" or lossless conversion of a single vibration in $N_2$ (heat) to a single photon (light) emitted below collisional threshold by a Rubidium atom in vacuum. Ernest's NSF post doc. at SUNNY Stony Brook, NY developed apparatus for a process known today as resonant multi-photon photoionization (RMPI), and was the first to practice it for supersonic beam cooled molecules, leading to very high citation research papers with Prof. Phil Johnson, including the report of collision induced multi photon ionization.

Ernest's first patented invention as Sr. Physicist at Airco Temescal in Berkeley CA ('83-'87), was for production of failure free ceramic thermal barrier coatings (TBC) on turbine engine blades and vanes. Ernest constructed a pilot 50keV e-beam evaporation furnace and developed one of the first fully computer stabilized processes for repeatable deposition of cubic zirconia TBCs is utilized worldwide today for failure free TBC coatings for all turbine engine first and second stage airfoils. His first magnetron sputter source patent was also for at Airco.

Ernest's second portfolio was developed at Varian Associates of Palo Alto CA ('87-'89) where his R&D team developed many patents for the full face erosion, low pressure planar magnetron sputter source and the first production cluster tools which are used throughout the semiconductor industry today and memorialized by a AMAT P5000 in the Smithsonian. His collimated sputtering patent for Varian solved major step coverage and contact barrier problems for deep semiconductor vias and was adopted widely and also by other OEM sputter equipment vendors. It also lead to Ernest being recruited by Applied Materials ('92-'98) to form Applied Komatsu (AKT) and develop wide area magnetron sputter machines for TFT-LCD display manufacture. He originated the linear scanning magnetron and sold ~ $100M of equipment with patents forming a third portfolio. While General Manager of the PVD Division, AMAT and IBM sued Ernest and Varian for fraud on patent office and claimed IBM invented the collimation process. That litigation went to $650M in damages and was settled in Varian and Ernest's favor. AMAT paid Varian/Novellus ~ $40M in damages, acknowledging Ernest's invention and patent for Varian Associates. AMAT allowed Ernest to spin out his PVD division out of AMAT/AKT with Corning and angel investor help to form Symmorphix Inc.(SI), Sunnyvale CA ('98-'07) where he led developed and patented his fourth portfolio for "biased" or ion assisted production of dense, defect free, reactive sputtered amorphous films, advancing the scanning magnetrons he had developed and subsequently purchased from AMAT/AKT. His SI team raised and earned more than $60M and developed new basic applications of the plasma bias process for encapsulation, capacitors, solid state thin film batteries and rare earth doped optical amplifiers. Symmorphix licensed two applications and delivered custom wide area cluster tools for manufacture. SI was purchased by Springworks Inc. of Minniapolis MN for ~ $30M ('05-'07) and shut down to transfer the large portfolio of patents. Springworks went into receivership ('08) and Ernest purchased the portfolio and the licenses from the receiver ('12) and formed Demaray LLC, Portola VA to hold and continue development and licensing of the SI IP. He had previously formed Antropy, DE as an operating company ('07) and was a sub-recipient of an ~ $1.5M DOE/ARPAe award with UCSC ('12).

In 2015, Ernest's two companies are working on advanced optical coupling technology which he believes will enable a wide range of optical energy delivery systems and products.

## Education/training

- Post Doctoral Fellow, Petroleum Research Foundation,
- State University of New York, Stony Brook, N.Y. 1977- 1979
- Ph.D. Chemical Physics, University of California at Santa Cruz, 1972-1977
- B.S. Physical Chemistry, California State University at Hayward,1972

## Employment history

- Founder and Managing Partner, Demaray LLC, Portola VA, CA 2012
- President & Founder, Antropy Inc., Portola Va. CA. Sept. 2007 to present,
- CTO Symmorphix Inc. Sunnyvale CA. Sept. 2005 – Aug. 2007,
- CEO Symmorphix Inc. Feb. 2004 – Sept. 2005,
- Founder, Chairman and CTO Symmorphix Inc. Oct. 1998-Feb. 2004, Sunnyvale, CA 1998-2004
- G.M.& Mg. Dir., PVD Division, Applied Komatsu-Tech. Santa Clara CA Sept. 1992-Oct. 1998
- Director Strategic Marketing, Varian Thin Film Systems Division 1989-1992
- R&D Director Thin Film Systems, Varian Assoc. Palo Alto, CA, 1987 to 1989
- New Products Manager, Airco-Temescal Division of BOC, Berkeley CA. 1983-1987
- Sr. Physicist, Turbine Coating Group, Airco-Temescal, Berkeley CA.1980 -1983
- Job Corps Councilor, Camp Parks Job Corps Center, Pleasanton CA.1969 - 1972

## Selected Publications;

- "The Dilemma of Solid State Lighting, Pt.1" invited Talk, 2011 North American Chinese Semiconductor Association NACSA, Campbell CA. Sept. 18, 2011.
- "Poly (3-hexylthiophen) field effect transistors with high dielectric constant TiO2 gate insulator" J. Apl. Phys V95, no1, 1 Jan. 2004. Wang, A . Heeger, M. Zhang, M. Narasimhan and E. Demaray,

- “Aluminosilicate Barrier and Encapsulation Technology for Polymer Electronics” USDC Flexible Displays & Electronics Conference, Phoenix Ar. Feb. 2005
- USDC grant, “Scanning Magnetron PVD for TCOs & OLED Encapsulation”, Symmorphix, ref. Rich Wessel, Dupont Elec., $2.19M, Q3/2003, awarded.
- “High dielectric strength, high k $TiO_2$ films by pulsed DC, reactive sputter deposition” CARTS Conference 2003, Hongmei Zhang and Ernest Demaray
- “High Dielectric Strength, High K $TiO_2$ Films by Pulsed DC, Reactive Sputter Deposition”, CARTS 2003, H. Zhang and Ernest Demaray, Huntsville, Al. 35801, 256-536-1304.
- Planar $Er^{+3}$ doped aluminosilicate waveguide amplifier with more than 10dB gain across the C-band, Proc. Optical Society of America 2002, T. Pan, H. Zang, E. Demaray
- “Microcrystalline-silicon thin films by physical vapor deposition for wide area low temperature polysilicon production” Ernest Demaray, JSID 9/1, 2001
- “Polysilicon Thin Film Transistors Obtained by Solid Phase Crystallization of DC Sputtered Amorphous Silicon Films” J. Proc. Group de Microslsctronique et Visualization, Universite de Rennes 1, FR, 2001
- “High Dielectric Strength, High K $TiO_2$ Films by Pulsed DC, Reactive Sputter Deposition”, CARTS 2003, CTI Inc. 904, H. Zhang and Ernest Demaray, Huntsville, Al. 35801, 256-536-1304.
- “Sputtered Silicon Thin Films for the Fabrication of Low Temperature Polycrystalline Silicon Devices”, W. K. Kwak, E. Demaray, R. Mullapudi, K. A. Wang, D. Toet, J. SID 2002
- Microcrystalline-silicon thin films by physical vapor deposition for wide-area low-temperature polysilicon production, Ernest Demaray, J. Soc. Inf. Display 9 15 (2001)
- D. Toet, E. Demaray, R. Mullapudi and K. A. Wang: Dig. Tech. Pap. Int. Workshop on Active-Matrix Liquid-Crystal Displays 2000, Tokyo, p. 117.
- E. Demaray, B. Lee, R. Mullapudi and K.-A. Wang: Proc. Sixth Int. Display Workshops, 1999 (Sendai International Center, Sendai, 1999) p. 155.
- “Low Damage RIE Process for Ideal TiW/n-Si Schottky Diodes” R. E. Demaray, R. K. Kolenkow, G. Mathias, Proc. SEMICON EAST Boston, p 38, 1986,
- “On the Mechanical Behavior of brittle Coatings and Layers,” A. G. Evans, R.E. Demaray, G. B. Crumley, Oxidation of metals, Vol. 20, Nos. 5/6, 1983.
- “Physical Vapor Deposition of Ceramic Coatings for Gas Turbine Engine Components.” R. E. Demaray, D. H. Boone, J. W. Fairbanks, Proc. ASME, 1982 Gas Turbine Conference, London England.
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## ***<u>US Patents by Patent Number</u>***

- “INORGANIC MATERIALS, METHODS AND APPARATUS FOR MAKING SAME,
- AND USES THEREOF” Apparatus, method and Devices for high rate deposition of Hexagonal and Cubic Aluminum Nitride; filed an application for United States Letters patent on September 29,2011, amended fall 2012, as U.S. Provisional Patent Application No.
- 61/540.558- Morgan AMG, with D.Brors, et. al.

- 61/725,400 - 2012 adiabatic planar waveguide coupler Transformer, Richard E. Demaray, Assigned to DemarayLLC
- 61/540,558 - 2012 Inorganic materials, methods and apparatus for making same, and uses there of.
- D. L. Brors, R. E. Demaray and D. L. Shultz – Assigned to Morgan Advanced Materials
- 8,173,482 – 2012 Devices and methods of protecting a cadmium sulfide for further processing, J. Drayton, R.E.Demaray – Assigned to G.E. PrimeStar Division, Arvada Colorado.
- 8,105,466 – 2012 Biased pulse DC reactive sputtering of oxide films – use of 2MHz bias for wide area processing of dielectric films.
- 8,076,005 -2011 Physical vapor deposition of titanium oxides and sub-oxides. Demaray, et. Al.
- 8,045,832 B2 -2011 Mode Size Converter for a Planar Waveguide, Tao Pan, Richard Demaray, Yu Chen, Youg Jin Xie, Ravi Pethe, Oct 25, 2011- Coupling efficiencies to 95%; single mode fiber waveguide, 8 claims
- 7,959,769 -2011 Deposition of LiCoO.sub2, Demaray et. al.
- 7,469,558 As-deposited planar optical waveguides with low scattering loss and methods for their manufacture – thin film planar optical waveguides with ion enhanced processes that minimize scattering loss (<-80db) due to sidewall roughness, 12 claims
- 7,413,998 Biased pulse DC reactive sputtering of oxide film, - rare earth doped optical waveguide multiplexer and amplifiers with attenuation control and gain, 13 claims.
- 7,404,877 Low temperature Zirconia based thermal barrier layer by PVD ,- for low laser fluence conversion of a-Si to p-Si, reduction of ELA full melt threshold, including transistors on polymer web, 6 claims.
- 7,381,657 Biased pulse DC reactive sputtering of oxide films, transition mode , - very high rate transition mode reactive oxide deposition inc. rare earth doped oxides, 21 claims.
- 7,378,356 Biased pulse DC reactive sputtering of oxide films , - claim 18 is the basic method for biased deposition of dense oxide films employing electrical charge control with reverse pulsed DC reactive process, including wide area manufacture; USPTO, “long anticipated results”, 35 claims.
- 7,262,131 Dielectric barrier layer films, - l single layer ceramic ultrabarrier “flexible micro-glass” film with ~ 100 nanometer low stress “Indium metal breath” process for low stress on polymer as barrier and on OLED/Solar as transparent encapsulation over live devices, 24 claims.
- 7,238,628 Energy conversion and storage films and devices by physical vapor deposition of titanium and titanium oxides and sub-oxides, - record dielectric strength for titania films with and without Er+3 doping, record high polymer transistor with high k titania gate, immune indifferent implantable, impermeable, high k implantable array gate oxide, record dielectric strength for 10nm film with and without rare earth doping, Magnelli phase control from conductive TiO targets for n-type Protonic oxide fuel cell membranes and un- depleted electrode/oxide interface devices, 42 claims.

- 7,205,662 , Dielectric barrier layer films – USDC verified, ~ 150nm, single layer ultrabarrier "flexible amorphous micro-glass" film including on PEN/PET web, performance claim all single layer films < E-2gr/M2-day permeation in damp heat, 24 claims. In pilot production at STMicro Electronics for integrated planar electronics on glass and products to Nokia.
- 6,884,327 Mode size converter for a planar waveguide , planar adiabatic mode size converter with <-80dB visible and IR, birefringence neutral, for mode size processing and fiber to die coupling of C-band optical signals including amplification of signal levels to ~ -40dB, 11 claims.
- 6,881,305 Heated and cooled vacuum chamber shield , adopted by PVD and CVD thin film manufacturing systems worldwide for improved particle control and high MTBF/MTTR, improved vacuum thin film quality, 6 claims.
- 6,827,826 Planar optical devices and methods for their manufacture, divisional with method of treating the cathode plate holding a wide area array of target tiles so as to eliminate contamination from the cathode without tile overlap or edge to edge contact, 5 claims.
- 6,821,562 Method of forming an electrically insulating sealing structure for use in a semiconductor manufacturing apparatus , replaces single piece main ceramic insulators for large scanning magnetrons with polymer/ceramic insulator construction, 20 claims.
- 6,773,562 Shadow frame for substrate processing, electrical control for the substrate perimeter shield for wide area substrates such as glass or metal foil, eliminates foil based edge damage and particles, 2 claims.
- 6,533,907 Method of producing amorphous silicon for hard mask and waveguide applications, dense amorphous silicon by harmonic conversion of merged AC and DC power, dense, oxidation resistant SI films for smooth hard mask and core optical wave guide devices, 4 claims.
- 6,506,289 Planar optical devices and methods for their manufacture, method of planarization of wave guide cladding, >~ 'BSQ' process pioneered by IBM for planarization, duel RF process utilized for defect free LIPON electrolyte glass over LiCo2 for solid state Li+ ion battery, see .pdf of [20070125638 Deposition of $LiCoO_2$ ] for figures, 32 claims.
- 6,436,509 Electrically insulating sealing structure and its method of use in a semiconductor manufacturing apparatus ,
- 6,432,203 Heated and cooled vacuum chamber shield , reactor liner for particle control of chamber, high MTBF/MTTR, improved vacuum thin film stress and first article quality with isothermal hearth side operation under transient high power processing, 12 claims.
- 6,362,097 Collimated sputtering of semiconductor and other films – wide area 'MBE' process and equipment for directed neutral vapor deposition of semiconductor films, including protection from plasma damage, fluorescent silicon films, assigned to AMAT, 31 claims.
- 6,257,045 Automated substrate processing systems and methods – position feedback using optical or contact, edge detection for real time next glass/wafer positional hand off, >500hr MTBF transfers for TFT-LCD/Solar cluster tool production without edge damage/breakage, 29 claims.

- 6,205,870 Automated substrate processing systems and methods – apparatus with in situ position sensing including location specific acoustical detection to robot transfer and placement of wide area glass for Solar/TFT-LCD manufacture, 22 claims.
- 6,199,259 Autoclave bonding of sputtering target assembly -
- 6,170,082 Taking corrective action in computer programs during instruction processing
- 6,033,483 Electrically insulating sealing structure and its method of use in a high vacuum physical vapor deposition apparatus
- 5,855,744 Non-planar magnet tracking during magnetron sputtering - scanning design/method to overcome the double curvature electron trap at opposite corners of a magnetron circuit and achieve ~ 1% 1 sigma film uniformity and low COO production, 42 claims.
- 5,799,860 Preparation and bonding of work pieces to form sputtering targets and other assemblies – vacuum super-plastic lamination of metallurgical sheets for high strength bonding including sputter backing plates and metallurgical targets, 16 claims.
- 5,676,803 Sputtering device – "PVD target backside vacuum-elegant design" adopted worldwide for TFT-LCD wide area PVD, AMAT withdrawn due to prior art; 1950 English magazine article, 12 claims.
- 5,635,036 Collimated deposition apparatus and method – storied, controversial PVD process invented and assigned to Varian/Novellus for directional Ti/TiN contact barrier metallization, required full face, low pressure sputter "Quantum" and "Endura" PVD source developments, Varian TFS Palo Alto won SEMATECH 200mm cluster tool competition/purchase for M-2000 vs. AMAT Endura (Dr. Jim Stimmell), qualified by 4 PVD vendors with customers worldwide, upheld in interference proceedings with AMAT– IBM due to extensive prior Monte Carlo simulation of the scattering process at Varian/UCSC (ref. Prof. R. Anderson), settled out of court," collimation" currently qualified for 200mm production with W and Cu metallization , 19 claims.
- 5,603,816 Sputtering device and target with cover to hold cooling fluid – elastomeric main insulator for target assembly, 2 claims
- 5,595,337 Sputtering device and target with cover to hold cooling fluid - a cooled target backing plate assembly with no water to vacuum seals and low aspect ratio to support high magnetic field sputtering for wide area, high power production of vacuum thin films, 3 claims
- 5,565,071 Integrated sputtering target assembly – a cooled target backing plate assembly with no water to vacuum seals and low aspect ratio to support high magnetic field sputtering for wide area, high power production of vacuum thin films ,11 claims.
- 5,518,593 Shield configuration for vacuum chamber – a radiantly heated, grounded dark space shield to prevent spurious plasma about the radial edge of the sputter cathode, is self aligning and self centered over thermal cycle excursions of +/- 500 deg. C with location variation < ~ +/- .010" for isothermal manufacture about a stationary wide area sputter target , eliminates overburden

flaking and particles, improves edge to center reflectance and resistivity uniformity, 34 claims.

- 5,487,822 Integrated sputtering target assembly – first allowance for cooled target backing plate assembly with no water to vacuum seals and low aspect ratio to support high magnetic field sputtering for wide area, high power production of vacuum thin films , 9 claims.
- 5,433,835 Sputtering device and target with cover to hold cooling fluid – first allowance for a cooled target backing plate assembly with no water to vacuum seals and low aspect ratio to support high magnetic field sputtering for wide area, high power production of vacuum thin films , 26 claims
- 5,330,628 Collimated deposition apparatus and method - storied, controversial PVD process invented and assigned to Varian/Novellus for directional Ti/TiN contact barrier metallization, required full face, low pressure sputter “Quantum” and “Endura” PVD source developments, Varian TFS Palo Alto, 15 claims.
- 5,252,194 Rotating sputtering apparatus for selected erosion- design of a rotating magnetic assembly that can provide full face erosion for particle control and arbitrary target erosion and film thickness profiles using the “Arc(r)/r “design rule produces magnets that are ‘heart shaped’ hence the “LUV” magnet designation. All semiconductor sputter sources utilize this design rule today, 28 claims
- 4,834,860 Magnetron sputtering targets – a pre-grooved, annular sputter target with a fixed magnetron can have improved target life and film uniformity, 13 claims.
- 4,676,994 Adherent ceramic coatings – thermal barrier coatings utilized on all turbine engines worldwide by this process and equipment. Failure free ceramic adhesion of cubic zirconia ceramic coatings up to many hundreds of microns is achieved in high rate production according to this invention. An initial coating of sub-stoichiometric zirconium oxide has liquid like nucleation and wetting of alumina forming super-alloy when coated at turbine engine operating conditions. This first process layer forms a transient “black liquid layer” ~ 5 microns thick which becomes transparent and solid when exposed to additional oxygen as the remainder of the low density, columnar “white popcorn” Zirconia ceramic layer is deposited on up to 24 blades and vanes in about 10 minutes. The fully oxidized coating is segmented through thickness and failure free in tension. It has the lowest thermal conductivity of known materials for high temperature combustion zone service and allows fuel efficient higher temperature turbine operation. The thick adherent ceramic layer obtains high fracture toughness and is failure free in compression at lower temperatures due to the fully dense adherent layer. This process is used on all turbine engine first and second hot section blades and vanes, 17 claims. It has saved 1-2% of all jet A fuel worldwide since the mid 1980s when it went into full production in Ernest’s pilot electron beam furnace ceramic evaporator at Airco Temescal in Berkeley Calif.

**William Franklin Krupke**
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Education: **Ph.D.**, Physics, Univ. of California at Los Angeles, 1966
**MA**, Physics, Univ. of California at Los Angeles, 1961
**BS**, Physics, Rensselaer Polytechnic Institute, 1958

**Professional Experience:**

2003-present WFK Lasers, LLC, Consultancy, **President**
1987-2003 Applied Lasers, Consultancy**, President**
1981-1999 LLNL, Laser Program, **Deputy Program Leader**
1980-1981 LLNL, Laser Program**, Chief Scientist**
- LLNL, Laser Program, **Deputy Y-Div Leader**
- Hughes Aircraft Co., Laser Division, **Associate Leader**
- Aerospace Corp, Laser Department, **Member Technical Staff**

1961-1961 Honeywell Corp, Laser Applications, **Member Technical Staff**
1958-1961 Hughes Aircraft Co., Microwave Dept., **Member Technical Staff**

**Executive Summary:**

Bill Krupke began his professional career at the Hughes Aircraft Company on a Masters Degree work-study fellowship. During this time, Bill performed technical development of non-linear ferromagnetic microwave devices for use in radar systems. Following award of the Masters of Arts degree in 1961, Bill worked briefly at the fledging Laser Applications Department on Honeywell Corp in Los Angeles where he participated in the development of one of the first ruby laser range finder systems. Later in 1961, Bill joined the newly formed Laser Department at the Aerospace Corporation in Los Angeles where he performed spectroscopic research on rare earth and transition metal doped luminescent materials suitable for use in solid state lasers. He also demonstrated one of the first erbium doped crystalline lasers emitting in the near infrared. Bill continued his graduate studies at UCLA earning the PhD degree in Physics by performing original research on the electronic structure of trivalent neptunium ions in a dielectric crystalline matrix, and on the application of a semi-empirical model of crystal-field-induced electric dipole transition intensities in crystals doped with trivalent rare ions.

In 1966, Bill returned to the Hughes Aircraft Company, Laser Division where he performed research on varies types of lasers, including infrared solid state lasers, infrared chemical lasers, nonlinear optical parametric oscillators, and $CO_2$ discharge and gas dynamic lasers. In particular, Bill was the first to systematically apply Judd-Ofelt optical transition probability theory to the identification of novel rare earth doped solid state laser materials.

In 1972, Bill co-founded the Laser Directorate at the Lawrence Livermore National Laboratory (LLNL), the organization responsible for the development and execution of the Laboratory's Inertial Confinement Fusion (ICF) and Atomic Vapor Laser Isotope Separation (AVLIS) national R&D programs. During his 27 years there, Bill variously served as Program Leader, Chief Scientist, and finally Deputy Associate Director for 20 years. At LLNL, Dr. Krupke led and participated in the design, development, and construction of evermore powerful Nd:glass lasers for fusion research (Janus, Argus, Shiva, Novette, and NOVA systems). He also engaged in the development of concepts and technologies for repetitively pulsed high-peak-power lasers suitable for driving future inertial fusion energy reactors, including KrF excimer and diode pumped solid state lasers. He also participated in the development of XeCl excimer, copper-vapor, and dye lasers for use in industrial scale uranium enrichment.

Since 1985 at LLNL, he was actively engaged in the development of diode-pumped high-average-power solid state lasers, and their uses in military, industrial, and commercial applications.

Bill has performed and published research on many types of gas and solid state lasers; he is internationally known for his work in developing and applying semi-empirical models and spectroscopic data bases to the invention and development of novel families of solid state lasers (various rare earth doped laser glasses, tunable chromium-doped colquriite crystals, tunable transition-metal doped chalcogenide crystals, and various Yb doped apatite crystals).

In 1987, Bill formed Applied Lasers (WFK Lasers, LLC since 2003), to provide technical consulting services to both private, venture-backed, and public companies engaged in commercial and industrial laser and photonic technologies. In May 1999, Krupke left LLNL to devote full time to this consulting endeavor, and to develop novel disruptive laser solutions with which to address emerging commercial and industrial laser applications. For 14 years, Bill served as a Director of the public company IPG Photonics, leading manufacturer of high power fiber lasers for commercial and industrial applications. He also is a retained consultant for several private high technology companies with photonics-centric products and applications, among them Crystal Photonics, and Foro Energy. At WFK Lasers, Krupke invented and patented a new class of lasers designated "diode-pumped alkali lasers, or DPALs, and more recently a novel diode-pumped molecular gas laser. The DPAL is presently undergoing significant development under DOD funding, and has achieved kilowatt output power levels.

Dr. Krupke is a Fellow of the Optical Society of America and is a Senior Member of the IEEE. He has served as an elected member of the Board of Directors of the Optical Society of America, and as chairperson of the Quantum Electronics, and the Photonics groups of the OSA Technical Council. He served as CLEO program and general co-chairs, and served for several years in various governance capacities for OSA's Topical

Advanced Solid State Lasers meeting. He has authored or co-authored over 70 scientific publications in the field of quantum electronics, has published several book chapters, has presented tens of invited talks (including several tutorial, keynote and plenary presentations at international laser conferences), and has authored or co-authored 25 patents. Journal publication, patent, and presentation lists are available upon request. He has served on the editorial boards of several prestigious international technical journals, including the Journal of Applied Physics, the Soviet Journal of Quantum Electronics, and the European Journal of Optics and Quantum Electronics.

Bill lives in Pleasanton, CA with Susan, his wife of 54 years; they have two adult children, and three grandchildren.

April, 2015

Krupke authored or co-authored US patents

| | Patent No. | Issue Date | Author(s) | Title |
|---|---|---|---|---|
| 1 | 4,004,250 | 1/18/1977 | W. F. Krupke | Laser Action by Optically Depumping Lower States |
| 2 | 4,053,852 | 10/11/1977 | W. F. Krupke | Near 16 Micron $CO_2$ Laser System |
| 3 | 4,053,851 | 10/11/1977 | W. F. Krupke | Method and Apparatus for Generating Coherent Near 14 and 16 Micron Radiation |
| 4 | 4,087,763 | 5/2/1978 | E. V. George, W. F. Krupke, J. R. Murray, H. T. Powell, C. Swingle, C. E. turner, C. K. Rhodes | Method and Apparatus for Secondary Laser Pumping by Electron Beam Excitation |
| 5 | 4,205,278 | 5/27/1980 | E. V. George, R. A. Haas, W. F. Krupke, L. G. Schlitt | Multiple Excitation Regenerative Amplifier Inertial Confinement System |
| 6 | 4,233,570 | 11/11/1980 | J. L. Emmett, R. R. Jacobs, W. F. Krupke, M. J. Weber | Tunable, Rare Earth Doped Solid State Lasers |
| 7 | 4,811,349 | 3/7/1989 | S. A. Payne, L. L. Chase, H. W. Newkirk, W. F. Krupke | $Cr^{3+}$ Doped Colquiriite Solid State Laser Materiual |
| 8 | 5,105,434 | 4/14/1992 | W. F. Krupke, S. A. Payne, | AlGaAs Diode Pumped Tunable Chromium Lasers |
| 9 | 5,260,954 | 11/9/1993 | C. B. Dane, E. V. George, J. L. Miller, W. F. Krupke | Pulse Compression and Prepulse Suppression Apparatus |
| 10 | 5,341,389 | 8/23/1994 | S. A. Payne, W. L. Kway, L. D. DeLoach, W. F. Krupke, B. H. T. Chai | Ytterbium and Nbeodymium Doped Vanadate Laser Host Crystals Having the Apatite Crystal Structure |
| 11 | 5,517,516 | 5/14/1996 | C. D. Marshall, S. A. Payne, W. F. Krupke | Optically Pumped Cerium Doped $LiSrAlF_6$ and $LiCaAlF_6$ |
| 12 | 5,526,372 | 6/11/1996 | G. Albrecht, E. V. George, W. F. Krupke, W. R. Sooy, S. B. Sutton | High Energy Bursts from a Solid State Laser Operated in the Heat Capacity Limited Regime |
| 13 | 5,541,948 | 7/30/1996 | W. F. Krupke, R. H. Page, L. D. DeLoach, S. A. Payne | Transition Metal Doped Sulfide, Selenide, and Telluride Laser Crystal and Lasers |
| 14 | 5,694,500 | 12/2/1997 | R. H. Page, K. I. Schaffers, S. A. Payne, W. F. Krupke, R. J. Beach | Optical Amplifier Operating at 1.3 Microns Useful for Telecommunications and Based on Dysprosium Doped Metal Chloride Host Materials |
| 15 | 6,047,013 | 4/4/2000 | S. A. Payne, R. H. Page, K. I. Schaffers, M. C. Nostrand, W. F. Krupke, P.G. Schungemann | Low Phonon Frequency Chalcogenide Crystalline Hosts for Rare Earth Lasers Operating Beyond Three Microns |
| 16 | 6,212,215 | 4/3/2001 | S. A. Payne, C. D. Marshall, H. T. Powell, W. F. Krupke | Hybrid Solid State Laser System Using a Neodymium Based Master Oscillator and an Yttrium Based Power Amplifier |
| 17 | 6,304,584 | 10/16/2001 | W. F. Krupke, S. A. Payne, C. D. Marshall | Blue Diode Pumped Solid State Laser Based on Ytterbium Doped Laser Crystals Operating on the Resonance Zero Phonon Transition |
| 18 | 6,347,109 | 2/12/2002 | R. J. Beach, E. C. Honea, C. Bibeau, H. T. Powell, W. F. Krupke, S. B. Sutton | High Average Power Scalable Thin Disk Laser |
| 19 | 6,643,311 | 11/4/2003 | W. F. Krupke | Diode Pump Alkali Laser |
| 20 | 6,693,942 | 2/17/2004 | W. F. Krupke | Diode Pumped Visible Wavelength Alkali Laser |
| 21 | 7,061,958 | 6/13/2006 | W. F. Krupke | Diode Pumped Alkali Lasers (DPALs) and Amplifiers (DPAAs) with Reduced Buffer Gas Pressures |
| 22 | 7,061,960 | 6/13/2006 | W. F. Krupke | Diode Pumped alkali Amplifier |
| 23 | 7,145,931 | 12/5/2006 | W. F. Krupke | Diode Pumped Alkali Molecular Lasers and Amplifiers |
| 24 | 7,283,576 | 10/16/2007 | W. F. Krupke | Optically Pumped DUV Atomic Vapor Lasers |
| 25 | 7,286,575 | 10/23/2007 | S. A. Payne, R. J. Beach, J. W. Dawson, W. F. Krupke | Diode Pumped Alkali Vapor Fiber Laser |

**Journal Publications**

1] M. T. Weiss, W. F. Krupke, and T. S. Hartwick, "Solid State X-Band Power Limiter",IEEE Transactions on Microwave Theory and Techniques, 9 (6) 472-480 (1961).

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