MICHAEL L. FULTON, M.A.
Ion Beam Optics Inc.
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EXPERIENCE

July 2003 to Present: President
Ion Beam Optics Inc. (IBO)
Developed UV Blocking Coating for Entech Lenses used in space power concentrator arrays. Produced high thermal emissivity coatings for AFRL thin-film solar cells. Phase I and Phase II SBIR program for AFRL—developing radiation resistant solar cell cover coatings. Laser eye protection and solar energy development programs for military and commercial applications Provided advanced design and process consultations for Thin Film Technology, Surface Optics, and Research Electro Optics. Developed the concept for depositing coatings on large area optics in space, and the Moon, for Astronomical observations and generation of space power. Introducing the space power technology (30% efficient) for producing electricity economically for terrestrial applications. Invited speaker at conferences and have chaired a technical sessions for SPIE.

September 2000 to July 2003: Principal Engineer
Rockwell Scientific Company (RSC)
Laser Eye Protection coating technology: Title III program to transfer technology from Thales to RSC; provided technical support to the ALEP (Aircrew Laser Eye Protection) program; program manager for the Boeing commercial airplane LEP development program. Program manager: Boeing landing-light coating development program; Raytheon laser protection coating programs; solar cell emissivity and thermal control coating program for AFRL. Principle investigator on: the narrow band pass development program; wedge and stripe filter programs for NASA and JHU; Compass filter program; and others. Responsible for supporting programs for Imaging, MEMES, Liquid Crystal Devices; Optical Materials and Devices; Micro-optics involving the application of advanced thin-film deposition technology.

November 1997 to September 2000: Technical Director
ZC&R Coatings for Optics Inc.
Focused on the development and implementation of innovative technology for the production of thin-film optical coatings. This included the application of the new High Output Ion-Assisted-Deposition (IAD) for depositing advanced coatings on temperature-sensitive substrates. Program manager and design engineer for the International Space Station Window coating project. In addition, developed the new Filtered Cathodic Arc technology for producing the super-hard thin-film coatings at room temperature for applications in the commercial, military, and aerospace industry.

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May 1993 to October 1997: Research and Development Specialist
Avimo Singapore Ltd., Singapore
Responsible for upgrading Avimo's thin-film optical coating technology in the manufacturing of precision optical components. Concentrated on the installation and process development of Ion Assisted Deposition (IAD) technology in the production of high performance optical fitters. Developed the first commercial contracts for Avimo from Europe (Zeiss, Hemzolt, Doctor Optics) for the production of high quality optical components. Developed robust manufacturing process for the ANVIS (night vision) programs. Established with the Singapore government a "Center of Thin-Film Excellence" at the Productivity Standards Board (PSB) facility that included other optics companies (II-VI; Leica; Plummer). Established a collaboration with Signapore Universities for the development of advanced coating technology including Filter Cathodic Arc (FCA) and IAD.

September 1990 to May 1993 : Research Scientist
Boeing Defense & Space Group, Seattle, WA (High Technology Center)
Provided Thin-Film Optical Coating support for a variety of programs in Boeing Developed an IAD capability which renders a superior optical film for a number of applications: Fiber Optical Interfaces; Optical Sensors; Optical Guided-wave Components; Advanced Electro-optical Components; Anti-reflection Coatings for world record Tandem Solar Cell; Gallium Arsenide Lasers; Wide Band LED's; and many others. Drawing upon I8 years of experience in this field, consulted on a number of programs including: Space Station Freedom; Electro-propulsion for Space; and Military Airplane programs. With members of the Prototype Development Group lead in the invention of a thin-film protective coating for a Silicone Fresnel Lens.

June 1989 to June 1990: Partner
PSI MAX Optics, Inc., Auburn, CA
Responsible for the design and production of a wide variety of "Hard Thin-Film Coatings" using IAD. Also, involved in the historically important "soft coating" technology which was advanced at PST MAX Optics to produce Ultra Narrow Band Passes (10 Angstrom wide; and 1 Angstrom variation across a 9" diameter substrate). Developed first WDM coating system that became the OCA/Corning prototype system for DWDM filter production.

May 1973 to June 1989: Thin-Film Process Engineer
Optical Coating Laboratory, Inc., Santa Rosa, CA
Process Engineering in the manufacturing of thin-film coatings in the Advanced Products Division of Optical Coating Laboratory Inc. This included such programs as: Solar Cell Covers for space applications; FLIR (Forward looking infrared) and Thermal Imaging Systems; Flight Simulator Windows; and Far Infrared Band Passes, Long Wave and Short Wave Pass filters for space applications, including: GOES weather satellites; Space Shuttle windows; Jupiter mission Galileo; and space solar power. Became the first person in the world to implement Ion Assisted Deposition technology into production, using the new griddles ion source. Worked on several projects that involved coatings for High Energy Laser applications for Lawrence Livermore Laboratory—the laser fusion programs.

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SIGNIFICANT PUBLICATIONS

1. Michael L. Fulton and Mark J. O'Neill, "Advanced Optical Coating Technology used in the Development of Concentrator Arrays for Solar Space Power Applications," Vacuum Technology and Coating Magazine, Volume 8, No. 2 48-59, (February 2007).
2. Michael L. Fulton and Jennifer D. T. Kruschwitz, Editors, *Advances in Thin-Film Coatings for Optical Applications II,* Proceedings of SPIE Vol. 5870 (2005)
3. M. L. Fulton, "Future Space-Based Deposition Technology for Solar Power and Astronomical Applications," *Vacuum Technology and Coating Magazine,* Volume 7, No. 2 46-52, (February 2006).
4. M. L. Fulton, "Future Space-Based Deposition Technology for Solar Power and Astronomical Applications," *Society of Vacuum Coaters, 48nd Annual Technical Conference Proceedings*, 83-89, (2005).
5. M. L. Fulton, "The Future Development of Energetic Thin-Film Processes for Spaced Based Depositions," Society *for the Advancement of Material and Process Engineering*, SAMPE Journal, (July 2005)
6. M. L. Fulton, "Developments in Energetic Processes for Optical Coating Applications," in *Advances in Thin Film Coatings for Optical Applications*, Jennifer D. T. Kruchwitz, James B. Oliver, Editors, Proceedings of SPIE Vol. 5527, 69-78 (2004)
7. M. L. Fulton, "A Futuristic View of Space-Based Deposition Processes," in *Optical Interference Coatings* on CD-ROM (The Optical Society of America, Washington, DC, 2004), MB2
8. M. L. Fulton, "Review of Cathodic Arc Deposition," *Optical Interference Coatings*, OSA Technical Digest (Optical Society of America, Washington DC, 2001) MD1-1-MD1-3.
9. Michael L. Fulton, Editor, *Optical and Infrared Thin Films*, Proceedings of SPIE Vol. 4094 (2000)
10. M. L. Fulton, "New Ion-Assisted Filtered Cathodic Arc Deposition (IFCAD) technology for producing advanced thin films on temperature-sensitive substrates," in *Solar Optical Materials XVI*, Carl M. Lampert, Caes-Goran Granqvist, Editors, Proceedings of SPIE Vol. 3789, 29-37 (1999)
11. M. L. Fulton, "Ion-Assisted Filtered Cathodic Arc Deposition (IFCAD) System for Volume Production of Thin-Film Coatings," *Society of Vacuum Coaters, 42nd Annual Technical Conference Proceedings* (1999).
12. Michael L. Fulton and Robert Cabrera, "Ion Assisted-Deposition using a High-Output End-Hall Ion Source," in *Optical Interference Coatings*, Vol. 9, OSA Technical Digest Series, (Optical Society of America, Washington DC, 1998), pp. 12-14
13. M. L. Fulton, D. Heshmaty, R. Mitchell, "Approaches explored for producing a variety of ion-assisted-deposited thin-film coatings using an end-Hall ion source," in *Developments in Optical Component Coatings*, Ian Reid, Editor, Proc. SPIE 2776, 114-125 (1996).
14. M. L. Fulton, Fu Ji Kai, and Tan Fong Hock, "Application of residual stress analysis for ion-assisted-deposited (IAD) thin-films manufactured using a gridless end-Hall ion source," *Optical Interference Coatings*, Vol. 17, 1995 OSA Technical Digest Series (Optical Society of America, Washington DC, 1995) 101-103.
15. M. L. Fulton, "Application of ion-assisted-deposition using a gridless end-Hall ion source for volume manufacturing of thin-film optical filters," in *Optical Interference Coatings*, Florin Abeles, Editor, Proc. SPIE 2253, (1994) 374-393.