GARRET MODDEL

CURRICULUM VITAE

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Professional Experience:

2021-present **Professor Emeritus**, University of Colorado at Boulder, Dept. of Electrical, Computer, & Energy Engineering. Research in quantum engineering device technology.

1996-2021 **Professor**, University of Colorado at Boulder

2007-2010 **President**, Society for Scientific Exploration

2001-2005 **President & CEO,** Phiar Corporation. Venture-backed start-up developing high-speed metal-insulator components.

1989-1996 **Associate Professor**, University of Colorado at Boulder

1990-1994 **Program Manager / Thrust Leader**, Materials & Devices Program / Ferroelectric Liquid Crystals Thrust in NSF Engineering Research Center for Optoelectronic Computing Systems at the University of Colorado

1985-1989 **Assistant Professor**, University of Colorado at Boulder

1981-1985 **Staff Scientist**, SERA Solar Corporation. Carried out research on solar energy materials and devices.

1977-1981 **Research Assistant**, Division of Applied Sciences, Harvard University. Investigated amorphous semiconductors under Professor William Paul.

Education:

Ph.D.	Applied Physics	Harvard University	1981
M.S.	Applied Physics	Harvard University	1978
B.S.	Electrical Engineering	Stanford University	1976
	with Distinction, Phi Beta Kappa, Tau Beta Pi		

Honors / Professional Service:

Fellow of the Optical Society of America
Lifetime Achievement Award from CU Technology Transfer 2003
Inventor of the Year in the Physical Sciences, 2002, University of Colorado
CU Eta Kappa Nu Teaching Award for Outstanding Professor for 1997/1998
Chair, program chair, and program committee member for multiple meetings of the Optical Society of America (OSA), Society for Scientific Exploration (SSE), Materials Research Society (MRS), and Institute of Electrical and Electronics Engineers (IEEE)
Vice president of the SSE 2015 - present

Member:

American Physical Society (APS)
Institute of Electrical & Electronics Engineers (IEEE), Life Senior Member
Society for Scientific Exploration

Peer-Reviewed Publications:

1. "A new development in the study of amorphous silicon hydrogen alloys: The story of O," M.A. Paesler, D.A. Anderson, E.C. Freeman, G. Moddel, and William Paul, Phys. Rev. Lett. *41*, 1492-1495 (1978).

2. "Importance of argon pressure in the preparation of rf-sputtered amorphous silicon-hydrogen alloys'," D.A. Anderson, G. Moddel, M.A. Paesler, and William Paul, J. Vac. Sci. Technol. *16*, 906 -912 (1979).

3. "The effect of gap state density on the photoconductivity and photoluminescence of a-Si:H," D.A. Anderson, G. Moddel, R.W. Collins and W. Paul, Solid State Commun. *31*, 677-681 (1979).

4. "An assessment of the suitability of rf sputtered amorphous hydrogenated Si as a potential solar cell material," D.A. Anderson, G. Moddel and William Paul, J. Elect. Mat. *9*, 141-182 (1980).

5. "Characterization of high gap state densities in heavily hydrogenated a-Si," D.A. Anderson, G. Moddel and William Paul, J. Non. Cryst. Solids *35-36*, 345-350 (1980).

6. "Photoluminescence in sputtered amorphous Si:H alloys," R.W. Collins, M.A. Paesler, G. Moddel and William Paul, J. Non. Cryst. Solids *35-36*, 681-686 (1980).

7. "Gap states in hydrogenated amorphous silicon: a comparison of photoemission and photoconductivity results," B. von Roedern and G. Moddel, Solid State Commun. *35*, 467-471 (1980).

8. "Derivation of the low energy optical absorption spectra of a-Si:H from photoconductivity," G. Moddel, D.A. Anderson and William Paul, Phys. Rev. B. *22*, 1918-1925 (1980).

9. "Interpretation of the conductance and capacitance frequency dependence of hydrogenated amorphous silicon Schottky barrier diodes," P. Viktorovitch and G. Moddel, J. Appl. Phys. *51,* 4847-4854 (1980).

10. "Carrier collection efficiencies in a-Si:H Schottky barrier solar cells," P. Viktorovitch, G. Moddel, J. Blake and W. Paul, J. Appl. Phys. *52*, 6203-6207 (1981).

11. "Density of states study in sputtered a-Si:H: effect of impurities and H-related defects," P. Viktorovitch, G. Moddel, J. Blake, S. Oguz, and W. Paul, J. de Physique *42*, Colloquy 4, 455-458 (1981).

12. "Effect of oxygen on the optoelectronic properties of amorphous hydrogenated silicon," B.G. Yacobi, R.W. Collins, G. Moddel, P.Viktorovitch, and W. Paul, Phys. Rev. B. *24*, 5907-5912 (1981).

13. "Optical absorption, photoconductivity and photoluminescence of glow discharge amorphous Si_{1-x} Ge_x alloys," B. von Roedern, D.K. Paul, J. Blake, R.W. Collins, G. Moddel, and W. Paul, Phys. Rev. B. *25*, 7678 (1982).

14. "Correlation of the photoelectrochemistry of the amorphous hydrogenated silicon/methanol interface with bulk semiconductor properties," C.M. Gronet, N.S. Lewis, G.W. Cogan, J.F. Gibbons, G.R. Moddel, and H. Weismann, J. Electrochem. Soc. *12*, 2873-2880 (1984).

15. "Design of efficient semiconductor/liquid junction interfaces in nonaqueous solvents," N.S. Lewis, R. Dominguez, C.M. Gronet, M. Lieber, M.D. Rosenblum, G.W. Cogan, J.F. Gibbons and G.R. Moddel, in *The Chemistry and Physics of Electrocatalysis,* J.D.E. McIntyre, M. J. Weaver and E.B. Yeager, editors (The Electrochemical Society, Princeton, 1984), pp. 460-479.

16. "The effect of deposition procedure on the conductivity of hydrogenated amorphous silicon multilayer films," G. Moddel, F.-C. Su and P. E. Vanier, *Materials Issues in Amorphous-Semiconductor Technology*, D. Adler, Y. Hamakawa and A. Madan, editors, Vol. 70 (Materials Research Society, Pittsburgh, 1986) pp. 423-428.

17. "Determination of the density of gap states in a-Si:H from studies of semiconductor/oxide multilayer films," R.B. Jones and G. Moddel, *Amorphous Silicon Semiconductors -- Pure and Hydrogenated,* A. Madan, M. Thompson, D. Adler and Y. Hamakawa, editors, Vol. 95 (Materials Research Society, Pittsburgh, 1987) pp. 393-398.

18. "Electro-optic applications of ferroelectric liquid crystals to optical computing," M.A. Handschy, K.M. Johnson, G. Moddel and L.A. Pagano-Stauffer, Ferroelectrics *85,* 279-289 (1988).

19. "Optical addressing of high-speed spatial light modulators with a-Si:H," G. Moddel, C.T. Kuo, K.M. Johnson and W. Li, *Amorphous Silicon Technology,* Vol. 118 (Materials Research Society, Pittsburgh, 1988) pp. 405-410.

20. "Drift mobility in hydrogenated amorphous silicon from photoconductivity decay," G. Moddel, and P. Viktorovitch, J. Appl. Phys. *1*, 205-209 (1989).

21. "Hydrogenated amorphous-silicon photosensor for optically addressed high-speed spatial light modulators," W. Li, R.A. Rice, G. Moddel, L.A. Pagano-Stauffer, and M.A. Handschy, IEEE Trans. Electron Devices *36*, 2959-2964 (1989).

22. "Motivations for using ferroelectric liquid crystal spatial light modulators in neurocomputing," K.M. Johnson and G. Moddel, Appl. Opt., *28*, 4888-4899 (1989).

23. "High speed binary optically addressed spatial light modulators," G. Moddel, K.M. Johnson, W. Li, R. A. Rice L.A. Pagano-Stauffer, and M.A. Handschy, Appl. Phys. Lett. *55*, 537-539 (1989).

24. "High-speed analog spatial light modulator using an a-Si:H photosensor and an electroclinic liquid crystal," I. Abdulhalim, G. Moddel, and K.M. Johnson, Appl. Phys. Lett. *55*, 1603-1605 (1989).

25. "A three-terminal spatial light modulator optically addressed by an a-Si:H photosensor," R.A. Rice, G. Moddel, I. Abdulhalim, and C.M. Walker, J. Non-Cryst. Solids, *115*, 96-98 (1989).

26. "Optically addressed electroclinic liquid crystal spatial light modulator with an a-Si:H photodiode," I. Abdulhalim, G. Moddel, K.M. Johnson, and C.M. Walker, J. Non-Cryst. Solids, *115*, 162-164 (1989).

27. "Joint transform correlator using an amorphous silicon ferroelectric liquid crystal spatial light modulator," D.A. Jared, K.M. Johnson, and G. Moddel, Optics Commun., *76*, 97-102 (1990).

28. "Compensating for light soaking effects in optically addressed spatial light modulators incorporating a-Si:H photodiodes," C.M. Walker, B. Landreth, and G. Moddel, *Amorphous Silicon Technology,* Vol. 192, (Materials Research Society, Pittsburgh, 1990) pp. 467-472.

29. "High-speed, low-power optical phase conjugation using a hybrid amorphous silicon/ferroelectric-liquid-crystal device," K.M. Johnson, C.C. Mao, G. Moddel, M.A. Handschy, and K. Arnett, Optics Lett., *15*, 1114-1116 (1990).

30. "Amorphous silicon for optically addressed spatial light modulators," G. Moddel, Ch. 11 in *Amorphous and Microcrystalline Semiconductor Devices: Optoelectronic Devices*, J. Kanicki, editor, (Artech House, Norwood MA, 1991) pp. 369-412.

31. "Optical phase conjugation using optically addressed chiral smectic liquid crystal spatial light modulators," C.C. Mao, K.M. Johnson, and G. Moddel, Ferroelectrics, *114*, 45-53 (1991).

32. "Switching behavior and electro-optic response due to the soft mode ferroelectric effect in chiral smectic A liquid crystals," I. Abdulhalim, and G. Moddel, Liq. Cryst., *9*, 493-518 (1991).

33. “Electrically and optically controlled light modulation and color switching using helix distortion of ferroelectric liquid crystals,” I. Abdulhalim, and G. Moddel, Mol. Cryst. Liq. Cryst., *200*, 79-101 (1991).

34. “Operating characteristics of an optically addressed spatial light modulator incorporating distorted helix ferroelectric liquid crystal,” B. Landreth, C.C. Mao, and G. Moddel, Jpn. J. Appl. Phys., *30*, 1400-1404 (1991).

35. “Response time of a-Si:H photodiodes for optically addressed spatial light modulators,” G. Moddel, and P.B. Barbier, *Amorphous Silicon Technology - 1991,* Vol. 219 (Materials Research Society, Pittsburgh, 1991) pp. 155-165.

36. “Photovoltaic optically addressed spatial light modulator,” C.C. Mao, B. Landreth, K.M. Johnson, and G. Moddel, Ferroelectrics, *122*, 455-466 (1991).

37. “Transient recovery of a-Si:H p-i-n photodiodes,” P. Barbier, and G. Moddel, J. Non-Cryst. Solids, *137 & 138*, 1301-1304 (1991).

38. “Director-polarization reorientation via solitary waves in ferroelectric liquid crystals,” I. Abdulhalim, G. Moddel, and N.A. Clark, Appl. Phys. Lett., *60*, 551-553 (1992).

39. “Grey-scale response from optically addressed spatial light modulators incorporating surface stabilized ferroelectric liquid crystals,” B. Landreth, and G. Moddel, Appl. Optics, *31*, 3937-3944 (1992).

40. “Hydrogenated amorphous silicon photodiodes for optical addressing of spatial light modulators,” P.B. Barbier, and G. Moddel, Appl. Optics, *31*, 3898-3907 (1992).

41. "Dynamic thresholding with the three-terminal optically addressed spatial light modulator," R.A. Rice, P.J. Close, and G. Moddel, *Amorphous Silicon Technology - 1992,* (Materials Research Society, Pittsburgh, 1992), pp. 1087-1092.

42. "Integrating mode for an optically addressed spatial light modulator," A.M. Gabor, B. Landreth, and G. Moddel, Appl. Optics, *32*, 3064-3067 (1993).

43. "An asynchronous image subtracting optically addressed spatial light modulator," P.R. Barbier and G. Moddel, *Amorphous Silicon Technology - 1993,* Vol. 297 (Materials Research Society, Pittsburgh, 1993) pp. 993-998.

44. "Analysis of ions in ferroelectric liquid crystals from hysteresis curves," S. Perlmutter, D. Doroski, and G. Moddel, Ferroelectrics, *149*, 319-331 (1993).

45. "High-reflectivity patterned metal mirror used in an optically addressed spatial light modulator," Q.h. Wu, S.H. Perlmutter, R.A. Rice, and G. Moddel, Opt. Engr., *33*, 946-950 (1994).

46. "Alignment layers for improved surface-stabilized ferroelectric liquid-crystal devices," D. Doroski, S. H. Perlmutter, and G. Moddel, Appl. Optics, *33*, 2608-2610 (1994).

47. "Thin-film photosensor design for liquid crystal spatial light modulators," P.R. Barbier, L. Wang, and G. Moddel, Opt. Engr., *33*, 1322-1329 (1994).

48. "Soliton switching in ferroelectric liquid crystals and their transient electro-optic response," I. Abdulhalim, G. Moddel, and N. Clark, J. Appl. Phys., *76*, 820-831 (1994).

49. "Effects of charge spreading on resolution of optically addressed spatial light modulators," L. Wang, and G. Moddel, Optics Lett., *19*, 2033-2035 (1994).

50. "Ferroelectric liquid crystal spatial light modulators," G. Moddel, Chap. 6 in *Spatial Light Modulator Technology: Materials, Devices, and Applications*, U. Efron, editor, (Marcel Dekker, New York, 1995) pp. 287-359.

51. "Fringe visibility improvement using an asynchronous image-subtracting optically addressed spatial light modulator," J. P. Sharpe, P. R. Barbier, G. Moddel, and K. M. Johnson, Appl. Optics, *34*, 4013-4021 (1995).

52. "Resolution limits from charge transport in optically addressed spatial light modulators," L. Wang, and G. Moddel, J. Appl. Physics, *78*, 6923-6935 (1995).

53. "A model of size-dependent photoluminescence in amorphous silicon nanostructures: comparison with observations of porous silicon," M. J. Estes and G. Moddel, Appl. Phys. Lett., *68*, 1814-1816 (1996).

54. "Characterization of the visible photoluminescence from anodized porous a-Si:H and a-Si:C:H thin films," M. J. Estes, L. R. Hirsch, S. Wichart, and G. Moddel, *Amorphous Silicon Technology - 1996,* M, Hack, E, A. Schiff, S, Wagner, R, Schropp, and A, Matsuda, ed., Vol. 420 (Materials Research Society, Pittsburgh, 1996) pp. 831-836.

55. "Degradation of liquid crystal device performance due to selective adsorption of ions," S. H. Perlmutter, D. Doroski, and G. Moddel, Appl. Phys. Lett., *69*, 1182-1184 (1996).

56. "Luminescence from amorphous silicon nanostructures," M. J. Estes, and G. Moddel, Phy. Rev. B15, *54*, 14,633-14,642 (1996).

57. "Visible photoluminescence from porous a-Si:H and porous a-Si:C:H thin films," M. J. Estes, L. R. Hirsch, S. Wichart, G. Moddel, and D. L. Williamson, J. Appl. Phys., *82*, 1832-1840 (1997).

58. "Fixed polarizer ellipsometry for simple and sensitive detection of thin films generated by specific molecular interactions: applications in immunoassays and DNA sequence detection," R. M. Ostroff, D. Maul, G. R. Bogart, S. Yang, J. Christian, D. Hopkins, K. Clark, B. Trotter, and G. Moddel, Clinical Chem., *44*, 2031-2035 (1998).

59. "Fixed-polarizer ellipsometry: a simple technique to measure the thickness of very thin films," B. Trotter, G. Moddel, R. Ostroff, and G. R. Bogart, Opt. Engr., *38*, 902-907 (1999).

60. "Fractional bandwidth normalization for optical spectra with application to the solar blackbody spectrum," G. Moddel, Appl. Optics, *40*, 413-416 (2001).

(On leave from University from 2001 to 2004 to start-up Phiar Corporation. For publications during this period see list of patents, below.)

61. "Entropy and subtle interactions," G. Moddel, J. Scientific Exploration, *18* (2), 293-306 (2004).

62. "Macroelectronics: Perspectives on Technology and Applications, " R. Reuss, with G. Moddel, et al., Proc. IEEE *93* (7), 1239-1256 (2005).

63. "Entropy and information transmission in causation and retrocausation," G. Moddel, Frontiers of Time, Retrocausation–Experiment and Theory, D. P. Sheehan, editor (American Institute of Physics, Melville, NY, 2006) pp. 62-74.

64. "Effect of Belief on Psi Performance," K. Walsh and G. Moddel, J. Scientific Exploration, *21* (3), 501-510 (2007).

65. "Traveling-Wave Metal/Insulator/Metal Diodes for Improved Infrared Bandwidth and Efficiency of Antenna-Coupled Rectifiers," S. Grover, O. Dmitriyeva, M. J. Estes, and G. Moddel, IEEE Trans. Nanotechnology, *99*, 716-722 (2010).

66. "Applicability of Metal/Insulator/Metal (MIM) Diodes to Solar Rectennas," S. Grover and G. Moddel, IEEE Journal of Photovoltaics, *1*, 78-83 (2011).

67. “Engineering the current–voltage characteristics of metal–insulator–metal diodes using double-insulator tunnel barriers," S. Grover and G. Moddel, Solid State Electron., 67, 94-99 (2011).

68. “Laboratory Demonstration of Retroactive Influence in a Digital System,” G. Moddel, Z. Zhu, and A. M. Curry, Quantum Retrocausation: Theory and Experiment, AIP Conf. Proc. 1408, D. P. Sheehan, editor (American Institute of Physics, Melville, NY, 2011) pp. 218-231.

69. “Mechanism for heat generation during deuterium and hydrogen loading of palladium nanostructures,” O. Dmitriyeva, R. Cantwell, M. McConnell, and G. Moddel, J. Condensed Matter Nucl. Sci. 8, 29–36 (2012).

70. “Ultrahigh Speed Graphene Diode with Reversible Polarity,” G. Moddel, Z. Zhu, S. Grover, and S. Joshi, Solid State Commun., 152, 1842-1845 (2012).

71. “Origin of excess heat generated during loading Pd-impregnated alumina powder with deuterium and hydrogen,” O. Dmitriyeva, R. Cantwell, M. McConnell, and G. Moddel, Thermochimica Acta, 543, 260–266 (2012).

72. “Quantum theory of operation for rectenna solar cells,” S. Grover, S. Joshi and G. Moddel, J. Phys. D: Appl. Phys. 46, 135106 (2013).

73. “Efficiency limits of rectenna solar cells: Theory of broadband photon-assisted tunneling," S. Joshi and G. Moddel, Applied Physics Letters, 102, 083901 (2013).

74. “Graphene Geometric Diodes for Terahertz Rectennas,” Z. Zhu, S. Joshi, S. Grover, and G Moddel, J. Phys. D: Appl. Phys. 46, 185101 (2013).

75. “Using Bakeout to Eliminate Heat from H/D Exchange During Hydrogen Isotope Loading of Pd-impregnated Alumina Powder,” O. Dmitriyeva, G. Moddel, R. Cantwell, and M. McConnell, J. Condensed Matter Nucl. Sci. 12, 13–17 (2013).

76. Rectenna Solar Cells, Garret Moddel and Sachit Grover, editors, (Springer, New York, 2013).

77. “Will Rectenna Solar Cells Be Practical?”, G. Moddel, Ch. 1 in *Rectenna Solar Cells*, G. Moddel and S. Grover, editors, pp. 3-24 (Springer, New York, 2013).

78. “Optical Frequency Rectification”, S. Grover, and G. Moddel, Ch. 2 in *Rectenna Solar Cells*, G. Moddel and S. Grover, editors, pp. 25-46 (Springer, New York, 2013).

79. “Efficiency Limits for Solar Spectrum Rectification”, S. Grover, S. Joshi, and G. Moddel, Ch. 3 in *Rectenna Solar Cells*, G. Moddel and S. Grover, editors, pp. 47-67 (Springer, New York, 2013).

80. “Metal Single-Insulator and Multi-Insulator Diodes for Rectenna Solar Cells”, S. Grover, and G. Moddel, Ch. 5 in *Rectenna Solar Cells*, G. Moddel and S. Grover, editors, pp. 89-109 (Springer, New York, 2013).

81. “Geometric Diodes for Optical Rectennas”, Z. Zhu, S. Joshi, S. Grover, and G. Moddel, Ch. 10 in *Rectenna Solar Cells*, G. Moddel and S. Grover, editors, pp. 209-227 (Springer, New York, 2013).

82. “Measurement Artifacts in Gas-Loading Experiments,” O. Dmitriyeva, R. Cantwell, and G. Moddel, J. Condensed Matter Nucl. Sci. 13, 106-113 (2014).

83. “Stock Market Prediction Using Associative Remote Viewing by Inexperienced Remote Viewers,” C. C. Smith, D. Laham, and G. Moddel, J. Scientific Exploration, 28 (1), 7-16 (2014).

84. “High Performance Room Temperature Rectenna IR Detectors Using Graphene Geometric Diodes,” Z. Zhu, S. Joshi, and G. Moddel, IEEE J. Selected Topics in Quantum Electronics, 20, 3801409 (2014), DOI 10.1109/JSTQE.2014.2318276.

85. “Quantum Rectennas for Photovoltaics,” Feng Yu, Garret Moddel and Richard Corkish, Ch. 16 in *Advanced Concepts in Photovoltaics,* A. J. Nozik, G. Conibeer, and M. C Beard, editors, pp. 506-546, (Royal Society of Chemistry, Cambridge, UK, 2014) DOI:10.1039/9781849739955-00506.

86. “Applied Psi,” P. H. Smith and G. Moddel, Ch. 29 in *Parapsychology: A Handbook for the 21st Century*, E. Cardeña, J. Palmer, and D. Marcusson-Clavertz, editors, pp. 380-388 (McFarland & Company, Jefferson, North Carolina, 2015).

87. “Rectennas at optical frequencies: How to analyze the response,” Saumil Joshi, and Garret Moddel, J. Appl. Phys., 118, 084503 1-6 (2015).

88. “Optical rectennas: Nanotubes circumvent trade-offs,” Garret Moddel, Nature Nanotechnology, 20, 1009-1010 (2015) doi:10.1038/nnano.2015.232.

89. “Simple Figure of Merit for Diodes in Optical Rectennas,” Saumil Joshi, and Garret Moddel, IEEE Journal of Photovoltaics, 6, 668-672 (2016).

90. "Graphene geometric diodes and antennas for terahertz applications," Zixu Zhu, Saumil Joshi, Bradley Pelz and Garret Moddel, Ch. 33, in *Graphene Science Handbook: Electrical and Optical Properties*, M. Aliofkhazraei, N. Ali, W. I. Milne, C. S. Ozkan, S. Mitura, and J. L. Gervasoni, editors, pp. 543–552 (CRC Press, Boca Raton, FL, 2016) DOI: 10.1201/b19642-37.

91. “Optical rectenna operation: where Maxwell meets Einstein,” Saumil Joshi and Garret Moddel, J. Phys. D: Appl. Phys. 49, 265602 (8 pp) (2016).

92. “High performance MIIM diode based on cobalt oxide/titanium oxide,” S. B. Herner, A. D. Weerakkody, A. Belkadi, and G. Moddel. Applied Phys. Lett., 110, 223901 (2017).

93. “Optical rectification through an Al_2O_3 based MIM passive rectenna at 28.3 THz,” G. Jayaswal, A. Belkadi, A. Meredova, B. Pelz, G. Moddel, and A. Shamim, Energy, 7, 1-9 (2018).

94. “Avoiding Erroneous Analysis of MIM Diode Current-Voltage Characteristics: Exponential Fitting,” B. Pelz, A. Belkadi, G. Moddel, Measurement, 120, 28-33 (2018).

95. “Responsivity–Resistance Relationship in MIIM Diodes,” S. Brad Herner, Amina Belkadi, Ayendra Weerakkody, Bradley Pelz, and Garret Moddel, IEEE J. Photovoltaics, 8 (2) (2018). DOI: 10.1109/JPHOTOV.2018.2791421

96. “Large Errors from Assuming Equivalent DC and High-Frequency Electrical Characteristics in Metal−Multiple-Insulator−Metal Diodes,” Amina Belkadi, Ayendra Weerakkody, and Garret Moddel, ACS Photnonics, 5 (12), 4776–4780 (2018). DOI: 10.1021/acsphotonics.8b01399

97. “Extraction of Zero-Point Energy from the Vacuum: Assessment of Stochastic Electrodynamics-Based Approach as Compared to Other Methods,” Garret Moddel and Olga Dmitriyeva, Atoms, 7 (51), 18 pages, (2019); DOI:10.3390/atoms7020051.

98. “Demonstration of distributed capacitance compensation in a metal-insulator-metal infrared rectenna incorporating a traveling-wave diode,” B. Pelz and G. Moddel, J. Appl Phys. 125234502 (2019); DOI: 10.1063/1.5083155.

99. "Effects of transmission line geometry on traveling-wave metal-insulator-metal rectenna infrared detectors." B. Pelz,, M. Armanious, and G. Moddel, J. Appl Phys. 126.6 (2019): 064503; DOI: 10.1063/1.5083154.

100. “Nonstoichiometric Nanolayered Ni/NiO/Al2O3/CrAu Metal−Insulator−Metal Infrared Rectenna,” Ayendra Weerakkody, Amina Belkadi, and Garret Moddel, ACS Appl. Nano. Mater., (2021). DOI: 10.1021/acsanm.0c03012

101. “Optical-Cavity-Induced Current,” G. Moddel, A. Weerakkody, D. Doroski, D. Bartusiak, Symmetry, 13(3), 517; doi.org/10.3390/sym13030517 (2021).

102. “Casimir-cavity-induced conductance changes,” G. Moddel, A. Weerakkody, D. Doroski, D. Bartusiak, Physical Review Research, 3, L022007 (2021); DOI: 10.1103/PhysRevResearch.3.L022007

103. “Demonstration of resonant tunneling effects in metal-double-insulator-metal (MI^2M) diodes,” Amina Belkadi, Ayendra Weerakkody, & Garret Moddel, Nature Communications, (2021) 12:2925 doi.org/10.1038/s41467-021-23182-0

104. "CVD-Grown Monolayer Graphene-Based Geometric Diode for THz Rectennas," Heng Wang, Gaurav Jayaswal, Geetanjali Deokar, John Stearns, Pedro MFJ Costa, Garret Moddel, and Atif Shamim, Nanomaterials 11, 1986 (2021).

105. “Simulation of Z-Shaped Graphene Geometric Diodes Using Particle-In-Cell Monte Carlo Method in the Quasi-Ballistic Regime,” John Stearns, and Garret Moddel, Nanomaterials , 11, 2361 (2021), doi.org/10.3390/nano11092361

Conference Presentations and Non-Peer-Reviewed Publications:

1. "Phototransport and its time decay in rf sputtered a-Si:H," G. Moddel and D.A. Anderson, Bull. Am. Phys. Soc. *24*, 500 (1979).

2. "Density of states near the valence band edge of hydrogenated a-Si:H," B. von Roedern and G. Moddel, Chelsea Amorphous and Liquid Semiconductor Meeting, 1979.

3. "Sub-bandgap absorption in a-Si:H derived from photoconductivity measurements," G. Moddel, J. Blake, D.A. Anderson and W. Paul, Bull. Am. Phys. Soc. *25*, 331 (1980).

4. "Gap state density determination from conductance and capacitance frequency dependence of a-Si:H Schottky solar cells," P. Viktorovitch and G. Moddel, Bull. Am. Phys. Soc. *25*, 329 (1980).

5. "Comparison of a-Si:H produced by rf sputtering and glow discharge methods," G. Moddel, J. Blake, R.W. Collins, P. Viktorovitch, D.K.Paul, B. von Roedern and W. Paul, in "*Tetrahedrally Bonded Amorphous Semiconductors*", Carefree, Arizona, AIP Conference Proceedings No. 73, edited by R.A.Street, D.K. Biegelsen, and J.C. Knights (American Institute of Physics, New York, 1981) pp.25-30.

6. "Evidence for an additional conductivity path in P-doped a-Si:H from Schottky barrier height and a photoconductivity temperature measurements," P. Viktorovitch, G. Moddel and W. Paul, *ibid*. pp. 186-191.

7. "Microstructure in a-GaAs:H alloys and its correlation with the electronic properties," D.K. Paul, J. Blake, G. Moddel and W. Paul, Thin Film Technologies and Special Applications, SPIE *346*, 95-104 (1982).

8. "Photoaddressing of high speed liquid crystal spatial light modulators," G. Moddel, K.M. Johnson and M.A. Handschy, Proc. SPIE *754* , 207-213 (1987).

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10. "Optical logic gates using photoaddressed ferroelectric liquid crystals," K.M. Johnson, G. Moddel, S.A. Anderson, and L.A. Pagano-Stauffer, OSA Tech. Dig. *22*, 55 (1987).

11. "Memory systems for optical computing," R.A. Schmidt and G. Moddel, *AIAA Computers in Aerospace VI Conference* (AIAA, Washington D.C., 1987), pp. 201-206.

12. "Design and performance of high-speed photoaddressed spatial light modulators," W. Li, C.T. Kuo, G. Moddel and K.M. Johnson, Proc. SPIE *936* , 48-55 (1988).

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