

Full list of refereed papers arranged by topic.

METAMATERIALS AND PLASMONICS:

1. "[Chemosensitive Gas Sensors Based on Plasmonic Nanohole Arrays](#)", Jeremy B. Wright, Kirsten N. Cicotte, Ganapathi Subramania, Shawn M. Dirk, and Igal Brener, Optical Materials Express **2**, 1655 (2012).
2. "[Optical Manipulation with Plasmonic Beam Shaping Antenna Structures](#)", Young Chul Jun, Igal Brener, Advances in OptoElectronics 2012.
3. "[Phase resolved near-field mode imaging for the design of frequency-selective surfaces](#)", Edward C. Kinzel, James C. Ginn, Robert L. Olmon, David J. Shelton, Brian A. Lail, Igal Brener, Michael B. Sinclair, Markus B. Raschke, and Glenn D. Boreman, Optics Express **20**, 11986-11993, 2011.
4. "[Realizing Optical Magnetism From Dielectric Metamaterials](#)", James C Ginn, Igal Brener, David W Peters, Joel R Wendt, Jeffrey O Stevens, Paul F Hines, Lorena I Basilio, Larry K Warne, Jon F Ihlefeld, Paul G Clem, Michael B Sinclair, Phys. Rev. Lett. **108**, 097402 (2012).
5. "[Theory and modeling of electrically tunable metamaterial devices using inter-subband transitions in semiconductor quantum wells](#)", A. Gabbay, I. Brener, Optics Express **20**, 6584-6597 (2012)
6. "[Active tuning of mid-infrared metamaterials by electrical control of carrier densities](#)", Young Chul Jun, Edward Gonzales, John L. Reno, Eric A. Shaner, Alon Gabbay, and Igal Brener, Optics Express **20**, 1903-1911 (2012).
7. "[Nonresonant Broadband Funneling of Light via Ultrasubwavelength Channels](#)", G. Subramania, S. Foteinopoulou, and I. Brener, Phys. Rev. Lett **107**, 163902 (2011)
8. "[Dynamic membrane projection lithography](#)", D. Bruce Burckel, Joel R. Wendt, Igal Brener, and Michael B. Sinclair, Optical Materials Express **1**, 962-969 (2011).
9. "[Releasable infrared metamaterials](#)", J. A. D'Archangel, G. D. Boreman, D.J. Shelton, M. B. Sinclair, and I. Brener, J. Vac. Sci. Technol. **B 29**, 051806 (2011) (doi:10.1116/1.3633695)
10. "[Interaction between metamaterial resonators and intersubband transitions in semiconductor quantum wells](#)", Alon Gabbay, John Reno, Joel R. Wendt, Aaron Gin, Michael C. Wanke, Michael B. Sinclair, Eric Shaner, and Igal Brener, Appl. Phys. Lett. **98**, 203103 (2011)
11. "[Strong Coupling between Nanoscale Metamaterials and Phonons](#)", D.J. Shelton, I. Brener, J. C. Ginn, M. B. Sinclair, D. W. Peters, K. R. Coffey, and G. D. Boreman, Nano Lett. **11**, 2104–2108, 2011.
12. "[Resonant coupling to a dipole absorber inside a metamaterial: Anticrossing of the negative index response](#)", Svyatoslav Smolev, Zahyun Ku, S. R. J Brueck, Igal Brener, Michael B. Sinclair, Gregory A. Ten Eyck, W. L. Langston, and Lorena I. Basilio, Journal of Vacuum Science & Technology B, **28** C6O16.
13. "[Micrometer-Scale Cubic Unit Cell 3D Metamaterial Layers](#)", D. Bruce Burckel, Joel R. Wendt, Gregory A. Ten Eyck, James C. Ginn, A. Robert Ellis, Igal Brener and Michael B. Sinclair, Advanced Materials **22**, 5053–5057, (2010).
14. "[Fabrication techniques for three-dimensional metamaterials in the midinfrared](#)", J. R. Wendt, D. B. Burckel, G. A. Ten Eyck, A. R. Ellis, I. Brener, and M. B. Sinclair, J. Vac. Sci. Technol. B **28**, C6O30 (2010).

15. "External modulators for TeraHertz Quantum Cascade Lasers based on electrically-driven active metamaterials", X.G. Peralta, I. Brener, W.J. Padilla, E.W. Young, A.J. Hoffman, M.J. Cich, R.D. Averitt, M.C. Wanke, J.B. Wright, H.-T. Chen, J.F. O'Hara, A.J. Taylor, J. Waldman, W.D. Goodhue, J. Li, J. Reno, *Metamaterials* **4**, 83-88, (2009).
16. "Nanocomposite plasmonic fluorescence emitters with core/shell configurations", Xiaoyu Miao, Igal Brener, and Ting Shan Luk, *JOSA B* **27**, 1561-1570 (2010).
17. "Fabrication of 3D Metamaterial Resonators Using Self-Aligned Membrane Projection Lithography", D. Bruce Burckel, Joel R. Wendt, Gregory A. Ten Eyck, A. Robert Ellis, Igal Brener, Michael B. Sinclair, *Advanced Materials* **22**, 3171–3175 (2010).
18. "Doping tunable resonance: Toward electrically tunable mid-infrared metamaterials", Xiaoyu Miao, Brandon Passmore, Aaron Gin, William Langston, Shivashankar Vangala, William Goodhue, Eric Shaner, and Igal Brener, *Appl. Phys. Lett.* **96**, 101111 (2010).
19. "Effect of thin silicon dioxide layers on resonant frequency in infrared metamaterials", D. J. Shelton, D. W. Peters, M. B. Sinclair, I. Brener, L. K. Warne, L. I. Basilio, K. R. Coffey, and G. D. Boreman, *Optics Express* **18**, 1085-1090 (2010).
20. "A spatial light modulator for terahertz beams", Wai Lam Chan, Hou-Tong Chen, Antoinette J. Taylor, Igal Brener, Michael J. Cich, and Daniel M. Mittleman, *Appl. Phys. Lett.* **94**, 213511 (2009).
21. "Large-area metamaterials on thin membranes for multilayer and curved applications at terahertz and higher frequencies", X. G. Peralta, M.C. Wanke, C.L. Arrington, J.D. Williams, I. Brener, A. Strikwerda, R.D. Averitt, W.J. Padilla, E. Smirnova, A.J. Taylor, and J. F. O'Hara, *Appl. Phys. Lett.* **94**, 161113 (2009).
22. "Metamaterials for THz polarimetric devices", Xomalin G Peralta, Evgenya I Smirnova, Abul K Azad, Hou-Tong Chen, Antoinette J Taylor, Igal Brener, John F O'Hara, *Opt. Express* **17**, 773-83 (2009).
23. "Thin-film sensing with planar terahertz metamaterials: sensitivity and limitations", John F O'Hara, Ranjan Singh, Igal Brener, Evgenya Smirnova, Jiaguang Han, Antoinette J Taylor, Weili Zhang, *Optics Express* **16**, 1786-1795, (2008).

NANOPHOTONICS:

24. "Single-mode lasing of GaN nanowire-pairs", Huiwen Xu, Jeremy B Wright, Ting-Shan Luk, Jeffery J Figiel, Karen Cross, Luke F Lester, Ganesh Balakrishnan, George T Wang, Igal Brener, Qiming Li, *Appl. Phys. Lett.* **101**, 113106-113106-4 (2012).
25. "Single-mode GaN nanowire lasers", Qiming Li, Jeremy B. Wright, Weng W. Chow, Ting Shan Luk, Igal Brener, Luke F. Lester, and George T. Wang, *Optics Express* **20**, 17873-17879, (2012)
26. "Nano-lithographically fabricated titanium dioxide based visible frequency three dimensional gap photonic crystal", Ganapathi Subramania, Yun-Ju Lee, Igal Brener, Ting-Shan Luk, Paul G Clem., *Optics Express* **15**, 13049-13057 (2007).
27. "CdSe infiltrated TiO₂ based omnidirectional photonic crystals for visible light control.", G. Subramania, Y.J. Lee, B.A. Hernandez-Sanchez, A.J. Fischer, T.S. Luk, I. Brener, P.G. Clem, and T.J. Boyle *Photonics and Nanostructures: Fundamentals and Applications* **6**, 12 (2008).

CHEM-BIO SENSING AND MICROFLUIDICS:

28. "[A platform for multiplexed sensing of biomolecules using high-Q microring resonator arrays with differential readout and integrated microfluidics](#)", JB Wright, I Brener, KR Westlake, DW Branch, MJ Shaw, GA Vawter, Proc. SPIE **7605**, 76050C (2010).
29. "[A microfluidic system combinig acoustic and dielectrophoretic particle preconcentration and focusing](#)", S. K. Ravula, D.W. Branch, C.D. James, R.J. Townsend, M. Hill, G. Kaduchak, M. Ward, and I. Brener, *Sensors and Actuators B: Chemical*, **130**, 645-652, (2008).
30. "Integration of microfluidics and microacoustics components for miniature flow cytometry systems", S.K. Ravula, D.W. Branch, J. Sigman, P.G. Clem, and I. Brener, *Sensors and Transducers*, Special Issue, 93-100, (2007).

(Older papers, pre-Sandia):

OPTICAL MEMS:

31. "[Design and Nonlinear Servo Control of MEMS Mirrors and Their Performance in a Large Port count Optical Switch](#)", P. B. Chu, I. Brener, C. Pu, S-S. Lee, J.I. Dadap, S. Park, K. Bergman, N. Bonadeo, T. Chau, M. Chou, R. Doran, R. Gibson, R. Harel, J. J. Johnson, C. D. Lee, D. R. Peale, B. Tang, D. Tong, M. Tsai, Q. Wu, W. Zhong, E. L. Goldstein, L. Y. Lin, and J. A. Walker, *Journal of microelectromechanical systems* **14**, 261 (2005).
32. "[Electrostatic actuation of three-dimensional MEMS mirrors using sidewall electrodes](#)", C. Pu, S. Park, P. B. Chu, S. S. Lee, M. Tsai, D. Peale, N. H. Bonadeo, and I. Brener, *IEEE Journal of Selected Topics in Quantum Electronics*, **10**, 472 (2004).
33. "[Reduction of cross-phase modulation-induced impairments in long-haul WDM telecommunication systems via spectral inversion](#)", G. L. Woods, P. Papaparaskeva, M. Shtaif, I. Brener, and D. A. Pitt, , *IEEE Photonics Technology Letters* **16**, 677 (2004).
34. "[Modular MEMS-based optical cross-connect with large port-count](#)", J. I. Dadap, P. B. Chu, I. Brener, C. Pu, C. D. Lee, K. Bergman, N. Bonadeo, T. Chau, M. Chou, R. Doran, R. Gibson, R. Harel, J. J. Johnson, S. S. Lee, S. Park, D. R. Peale, R. Rodriguez, D. Tong, M. Tsai, C. Wu, W. Zhong, E. L. Goldstein, L. Y. Lin, and J. A. Walker, *IEEE Photonics Technology Letters* **15**, 1773 (2003).

WAVELENGTH CONVERSION AND FIBER TELECOMM:

35. "[Tunable all-optical time-slot-interchange and wavelength conversion using difference-frequency-generation and optical buffers](#)", M. C. Cardakli, D. Gurkan, S. A. Havstad, A. E. Willner, K. R. Parameswaran, M. M. Fejer, and I. Brener, *IEEE Photonics Technology Letters*, **14**, 200 (2002).
36. "[Interchannel cross talk caused by pump depletion in periodically poled LiNbO₃ waveguide wavelength converters](#)", R. Harel, W. H. Burkett, G. Lenz, E. E. Chaban, K. R. Parameswaran, M. M. Fejer, and I. Brener, *Journal of the Optical Society of America B (Optical Physics)* **19**, 849 (2002).
37. "[Polarisation-insensitive wavelength converter based on cascaded nonlinearities in LiNbO₃ waveguides](#)", I. Brener, M. H. Chou, E. Chaban, K. R. Parameswaran, M. M. Fejer, S. Kosinski, and D. L. Pruitt, *Electronics Letters* **36**, 66 (2000).

38. "[160 Gbit/s wavelength shifting and phase conjugation using periodically poled LiNbO₃ waveguide parametric converter](#)", I. Brener, B. Mikkelsen, G. Raybon, R. Harel, K. Parameswaran, J. R. Kurz, and M. M. Fejer, *Electronics Letters* **36**, 1788 (2000).
39. "[Efficient wide-band and tunable midspan spectral inverter using cascaded nonlinearities in LiNbO₃ waveguides](#)", M. H. Chou, I. Brener, G. Lenz, R. Scotti, E. E. Chaban, J. Shmulovich, D. Philen, S. Kosinski, K. R. Parameswaran, and M. M. Fejer, *IEEE Photonics Technology Letters* **12**, 82 (2000).
40. "[Optical signal processing and switching with second-order nonlinearities in waveguides](#)", M. H. Chou, K. R. Parameswaran, M. M. Fejer, and I. Brener, *IEICE Transactions On Electronics* **E83C**, 869 (2000).
41. "[Waveguide frequency mixers for all-optical signal processing](#)", K. Parameswaran, M. H. Chou, M. M. Fejer, I. Brener, and S. Kawanishi, *OSA Trends in Optics and Photonics* **46**, 156 (2000).
42. "[Cascaded chi^{\(2\)} wavelength converter in LiNbO₃ waveguides with counter-propagating beams](#)", I. Brener, M. H. Chou, D. Peale, and M. M. Fejer, *Electronics Letters* **35**, 1155 (1999).
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44. "[Multiple-channel wavelength conversion by use of engineered quasi-phase-matching structures in LiNbO₃ waveguides](#)", M. H. Chou, K. R. Parameswaran, M. M. Fejer, and I. Brener, *Optics Letters* **24**, 1157 (1999).
45. "[Stability and bandwidth enhancement of difference frequency generation \(DFG\)-based wavelength conversion by pump detuning](#)", M. H. Chou, I. Brener, K. R. Parameswaran, and M. M. Fejer, *Electronics Letters* **35**, 978 (1999).
46. "[Multistage dispersion compensator using ring resonators](#)", C. K. Madsen, G. Lenz, A. J. Bruce, M. A. Capuzzo, L. T. Gomez, T. N. Nielsen, and I. Brener, *Optics Letters* **24**, 1555 (1999).
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TERAHERTZ SCIENCE AND TECHNOLOGY:

48. "[Terahertz near-field imaging](#)", J. F. Federici, O. Mitrofanov, M. Lee, J. W. P. Hsu, I. Brener, R. Harel, J. D. Wynn, L. N. Pfeiffer, and K. W. West, *Physics in Medicine and Biology* **47**, 3727 (2002).
49. "[Collection-mode near-field imaging with 0.5-THz pulses](#)", O. Mitrofanov, M. Lee, J. W. P. Hsu, I. Brener, R. Harel, J. F. Federici, J. D. Wynn, L. N. Pfeiffer, and K. W. West, *IEEE Journal of Selected Topics in Quantum Electronics* **7**, 600 (2001).
50. "[Tunable coherent far infrared radiation emission from biased semiconductor microcavities](#)", R. Harel, I. Brener, L. N. Pfeiffer, K. W. West, J. M. Vandenberg, S. G. Chu, and J. Wynn, *physica status solidi (a)* **178**, 365–372 (2000).

51. "[Near-field microscope probe for far infrared time domain measurements](#)", O. Mitrofanov, I. Brener, M. C. Wanke, R. R. Ruel, J. D. Wynn, A. J. Bruce, and J. Federici, *Applied Physics Letters* **77**, 591 (2000).
52. "[Terahertz near-field microscopy based on a collection mode detector](#)", O. Mitrofanov, I. Brener, R. Harel, J. D. Wynn, L. N. Pfeiffer, K. W. West, and J. Federici, *Applied Physics Letters* **77**, 3496 (2000).
53. "Time resolved near field imaging and diffraction with sub-wavelength far-infrared dipole sources", I. Brener, S. Hunsche, Y. Cai, M. C. Nuss, J. Wynn, J. Lopata, and L. Pfeiffer, *Springer Series in Chemical Physics* **63**, 171 (1998).
54. "[Coherent terahertz radiation detection: Direct comparison between free-space electro-optic sampling and antenna detection](#)", Y. Cai, I. Brener, J. Lopata, J. Wynn, L. Pfeiffer, J. B. Stark, Q. Wu, X. C. Zhang, and J. F. Federici, *Applied Physics Letters* **73**, 444 (1998).
55. "[THz near-field imaging](#)", S. Hunsche, M. Koch, I. Brener, and M. C. Nuss, *Optics Communications* **150**, 22 (1998).
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57. "[Coherent control of terahertz emission and carrier populations in semiconductor heterostructures](#)", I. Brener, P. C. M. Planken, M. C. Nuss, M. S. C. Luo, S. L. Chuang, L. Pfeiffer, and D. E. Leaird, *Journal of the Optical Society of America B (Optical Physics)* **11**, 2457 (1994).
58. "[Generation of terahertz electromagnetic pulses from quantum-well structures](#)", M. S. C. Luo, S. L. Chuang, P. C. M. Planken, I. Brener, H. G. Roskos, and M. C. Nuss, *IEEE Journal of Quantum Electronics* **30** 1478 (1994).
59. "[Terahertz electromagnetic radiation from quantum wells](#)", M. C. Nuss, P. C. M. Planken, I. Brener, H. G. Roskos, M. S. C. Luo, and S. L. Chuang, *Applied Physics B-Lasers and Optics* **B58**, 249 (1994).
60. "[THz radiation from coherent population changes in quantum wells](#)", P. C. M. Planken, I. Brener, M. C. Nuss, M. S. C. Luo, S. L. Chuang, and L. N. Pfeiffer, *Physical Review B* **49**, 4668 (1994).
61. "[Repetitive excitation of charge oscillations in semiconductor heterostructures](#)", I. Brener, P. C. M. Planken, M. C. Nuss, L. Pfeiffer, D. E. Leaird, and A. M. Weiner, *Applied Physics Letters* **63**, 2213 (1993).
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63. "[Coherent control of terahertz charge oscillations in a coupled quantum well using phase-locked optical pulses](#)", P. C. M. Planken, I. Brener, M. C. Nuss, M. S. C. Luo, and S. L. Chuang, *Physical Review B* **48**, 4903 (1993).
64. "[Terahertz emission in single quantum wells after coherent optical excitation of light hole and heavy hole excitons](#)", P. C. M. Planken, M. C. Nuss, I. Brener, K. W. Goossen, M. S. C. Luo, S. L. Chuang, and L. Pfeiffer, *Physical Review Letters* **69**, 3800 (1992).

SEMICONDUCTORS (GaAs, III-N, EXCITONS, ETC):

65. "Nonuniform morphology and luminescence properties of a molecular beam epitaxy GaN film from atomic force microscopy, scanning electron microscopy and cathodoluminescence", L. L. Chao, G. S. Cargill, C. Kothandaraman, D. Cyr, G. Flynn, E. S. Hellman, D. Wiesmann, D. N. E. Buchanan, and I. Brener, MRS Internet Journal of Nitride Semiconductor Research **2**, U3 (1997).
66. "[Photoluminescence study of high quality InGaN-GaN single heterojunctions](#)", CJ Sun, JW Yang, Q Chen, BW Lim, M Zubair Anwar, M Asif Khan, H Temkin, D Weismann, I Brenner, Applied Physics Letters **69**, 668 (1996).
67. "ScAlMgO₄: An oxide substrate for GaN epitaxy", E. S. Hellman, C. D. Brandle, L. F. Schneemeyer, D. Wiesmann, I. Brener, T. Siegrist, G. W. Berkstresser, D. N. E. Buchanan, and E. H. Hartford, MRS Internet Journal of Nitride Semiconductor Research **1**, U3 (1996).
68. "Growth of Ga-face and N-face GaN films using ZnO substrates", E. S. Hellman, D. N. E. Buchanan, D. Wiesmann, and I. Brener, MRS Internet Journal of Nitride Semiconductor Research **1**, U117 (1996).
69. "[Nonlinear optical study of the Fermi edge singularity: differences from atomic excitons in the virtual excitation regime](#)", I. E. Perakis, I. Brener, W. H. Knox, and D. S. Chemla, Journal of the Optical Society of America B (Optical Physics) **13**, 1313 (1996).
70. "[Gain spectra and stimulated emission in epitaxial \(In,Al\)GaN thin films](#)", D. Wiesmann, I. Brener, L. Pfeiffer, M. A. Khan, and C. J. Sun, Applied Physics Letters **69**, 3384 (1996).
71. "[Virtual excitation of the Fermi-edge singularity in modulation-doped quantum wells](#)", I. Brener, W. H. Knox, and W. Schaefer, Physical Review B **51**, 2005 (1995).
72. "[Many-Body Effects at the Fermi Edge of Modulation-Doped Semiconductors: a Numerical Study](#)", W. Schafer, I. Brener, and W. Knox, *Nato Advanced Science Institutes Series, Series B, Physics* **330**, 343 (1994).
73. Generatie van terahertz-licht in quantumpotten", PCM Planken, I Brener, MC Nuss, Nederlands Tijdschrift voor Natuurkunde **15**, 237
74. "[Shallow quantum well excitons: 2D or 3D?](#)", I. Brener, W. H. Knox, K. W. Goossen, and J. E. Cunningham, Physical Review Letters **70**, 319 (1993).
75. "[Annealing of Cd-implanted GaAs: defect removal, lattice site occupation, and electrical activation](#)", N. Moriya, I. Brener, R. Kalish, W. Pfeiffer, M. Deicher, R. Keller, R. Magerle, E. Recknagel, H. Skudlik, T. Wichert, and H. Wolf, Journal of Applied Physics **73**, 4248 (1993).
76. "[Particle localization and phonon sidebands in GaAs/Al_xGa_{1-x}As multiple quantum wells](#)", I. Brener, M. Olszakier, E. Cohen, E. Ehrenfreund, A. Ron, and L. Pfeiffer, Physical Review B **46**, 7927 (1992).

77. "[Resonant Raman scattering mediated by excitons in CdTe/CdZnTe multiple quantum wells](#)", Y. Garini, H. Tuffigo, I. Brener, E. Cohen, N. Magnea, and H. Mariette, Journal of Luminescence **53**, 348 (1992).
78. "[Experimental evidence of Bragg confinement of carriers in a quantum barrier](#)", M. Zahler, I. Brener, G. Lenz, J. Salzman, E. Cohen, and L. Pfeiffer, Applied Physics Letters **61**, 949 (1992).
79. "[Decay times of excitons in lattice-matched InGaAs/InP single quantum wells](#)", I. Brener, D. Gershoni, D. Ritter, M. B. Panish, and R. A. Hamm, Applied Physics Letters **58**, 965 (1991).
80. "[Anisotropic optical properties of \(110\)-oriented quantum wells](#)", D. Gershoni, I. Brener, G. A. Baraff, S. N. G. Chu, L. N. Pfeiffer, and K. West, Physical Review B **44**, 1930 (1991).
81. "[Resonant Raman scattering by acceptors and LO phonons in GaAs/AlGaAs multiple quantum wells](#)", I. Brener, E. Cohen, A. Ron, and L. Pfeiffer, Surface Science **228**, 180 (1990).
82. "[Resonant Raman scattering by acceptors in GaAs/Al_xGa_{1-x}As multiple quantum wells: a probe of exciton localization](#)", I. Brener, E. Cohen, A. Ron, and L. Pfeiffer, Physical Review B **42**, 11035 (1990).
83. "[Intervalence-band photoinduced absorption in undoped GaAs/Al_xGa_{1-x}As multiple-quantum wells](#)", M. Olszakier, I. Brener, E. Ehrenfreund, and E. Cohen, Superlattices and Microstructures **7**, 291 (1990).
84. "[Metalorganic molecular beam epitaxy of InP, Ga_{0.47}In_{0.53}As, and GaAs with tertiarybutylarsine and tertiarybutylphosphine](#)", D. Ritter, M. B. Panish, R. A. Hamm, D. Gershoni, and I. Brener, Applied Physics Letters **56**, 1448 (1990).
85. "[Localized and extended exciton states in narrow GaAs/AlGaAs quantum wells](#)", I. Brener, E. Cohen, A. Ron, and L. Pfeiffer, Superlattices and Microstructures **5**, 223 (1989).
86. "[Resonant Raman scattering mediated by intrinsic excitons in Cd_{1-x}Zn_xTe \(x ~ 0.5\)](#)", I. Brener, E. Cohen, A. Muranevich, and R. Triboulet, Physical Review B **40**, 8313 (1989).

PATENTS (granted):

1. "Method and Apparatus for Near Field Field, Scanning, Optical Microscopy by Reflective Optical Feedback", issued 1995, U.S. Patent Number 5,389,779.
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3. "Terahertz Generators and Detectors", issued 1998, U.S. Patent Number 5,729,017.
4. "Near Field THz imaging", issued 1999, U.S. Patent Number 5,894,125.
5. "Dispersion mapping in optical fibers", issued 2000, U.S. Patent Number 6,118,523.

6. "A waveguide with reduced pump depletion", issued 2002, Patent Number 6,411,757.
7. "Optical Transmision System with Reduced Kerr Effect Nonlinearities", issued 2004, Patent Number 6704519.
8. "Optical switch and method for aligning optical switch components", issued 2003, Patent Number 6,529,652
9. "Optical monitoring of the angular position of micro mirrors in an optical switch", issued 2003, Patent Number 6,549,692.
10. "Voltage reduction in integrated control systems of mirrors", issued 2003, Patent Number 6,597,827
11. "Optical switch with an array of offset angled micro-mirrors", issued 2003, Patent Number 6,628,857.
12. "Optical switch having MEMS array with reduced optical loss", issued 2004, Patent Number 6,690,849.
13. "Optical transmission system with reduced Kerr effect nonlinearities", issued 2004, Patent Number 6,704,519.