

Bart J. Van Zeghbroeck, Professor

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Education:

Aug. 1984 **Ph.D.** in Electrical Engineering, University of Colorado at Boulder
Aug. 1981 **M.S.** in Electrical Engineering, University of Colorado at Boulder
July 1980 **Diploma** of Electrical Engineer, Katholieke Universiteit, Leuven, Belgium.

Professional Experience:

6/2000 – present **Professor**, University of Colorado
7/2006 – 9/2006 **Director**, Boulder advanced Technology Center, Microsemi Corp.
1/2002 – 8/2004 **Founder and Chief Technology Officer**, PowerSicel Inc.
9/2001 – 12/2001 **Managing Director of Research and Development**, Eagle R&D.
6/2001 – present **Director**, Micro/Nano Research and Teaching Laboratory, Univ. of Colorado
5/1995 - 7/1995 **Visiting Professor**, University of Ulm, Germany.
1/1990 – 6/2000 **Associate Professor**, University of Colorado at Boulder.
Teaching in the area of thermodynamics, solid state physics, micro/nanofabrication, electronic and optoelectronic devices and circuits.
Research and scholarly interest in high-speed electronic, superconducting and optoelectronic devices with emphasis on devices for optoelectronic integrated circuits and high-temperature electronics.

9/1984 - 12/1989 **Research staff Member**, IBM Zürich Research Laboratory, Switzerland.
Initiated a research program on submicron-gate-length GaAs MESFETs with thin epitaxial channel; demonstrated high performance devices, logic circuits as well as high-speed photodiodes and optoelectronic receivers.

6/1981 - 8/1984 **Research Assistant**, National Institute of Standards and Technology

Miscellaneous

- **IBM** first patent award, first and second invention award, research division award and outstanding technical achievement award.
- University of Colorado Doctoral **Fellowship**, 1981-1982
- **IEEE** senior member since 1999, member since 1977
- **DAAD** (Deutsche Akademische Austausch Dienst) **fellowship recipient**, Summer 1995
- **Device Research Conference** General Conference Chair 1999, Technical Program Chair, 1998, Local arrangements Chair, 1991, 1994
- **Referee for:** Solid State Electronics, IEEE Transactions on Electron Devices, Electronics Letters, IEEE Photonics Technology Letters, IEEE Transaction of Applied Superconductivity, Department of Energy, National Science Foundation
- **90 Publications, 10 patents**

Bart J. Van Zeghbroeck - Publication List

Peer-reviewed Journal Publications

1. Bart J. Van Zeghbroeck, "Superconducting Current Injection Transistor", Appl. Phys. Lett., Vol. 42, No.8, pp 736-738 (1983).
2. P. Wolf, B. J. Van Zeghbroeck and U. Deutsch, "A Josephson Sampler with 2.1ps Resolution", IEEE Trans. Mag., Vol. MAG-21, No.2, pp 226-229 (1985).
3. Bart J. Van Zeghbroeck, "Superconducting Current Injection Transistor with very high Critical-Current-Density Edge-Junctions", IEEE Trans. Mag., Vol. MAG-21, No.2, pp 916-919 (1985).
4. B. J. Van Zeghbroeck, "Model for a Josephson Sampling Gate", J. Appl. Phys., Vol. 57, No.7, pp 2593-2596 (1985).
5. B. J. Van Zeghbroeck, "Comment on 'Effect of Magnetic Field on n^+n^+ GaAs Ballistic Diode'", Electr. Lett., Vol. 21, No.19, p 848 (1985).
6. H. Jäckel, V. Graf, B. J. Van Zeghbroeck, P. Vettiger, and P. Wolf, "Scaled GaAs MESFET's with Gate Length Down to 100nm", IEEE Electr. Dev. Lett., Vol. EDL-7, pp 522-524 (1986).
7. B. J. Van Zeghbroeck, W. Patrick, H. Meier, and P. Vettiger, "Submicrometer GaAs MESFET with Shallow Channel and Very High Transconductance", IEEE Electron Dev. Lett, Vol. EDL-8, pp 118-120 (1987).
8. B. J. Van Zeghbroeck, W. Patrick, H. Meier, and P. Vettiger, "Parasitic Bipolar Effects in Submicrometer GaAs MESFET's", IEEE Electron Dev. Lett, Vol. EDL-8, pp 188-190 (1987).
9. Ch. Harder, B. J. Van Zeghbroeck, H. Meier, W. Patrick, and P. Vettiger, "5.2 GHz Bandwidth Monolithic GaAs Optoelectronic Receiver", IEEE Electron Dev. Lett., EDL-8, pp 171-173, 1988.
10. B. J. Van Zeghbroeck, W. Patrick, J.-M. Halbout, and P. Vettiger, "105 GHz Bandwidth Metal-Semiconductor-Metal Photodiode", IEEE Electron Dev. Lett., EDL-10, pp 527-529, 1988.
11. B. J. Van Zeghbroeck, "Analysis of Picosecond and Subpicosecond MSM Photodiodes with Very Low Bias Voltage", IEEE Trans. Electr. Dev., Vol.35, p 2433, 1988.
12. P. Vettiger, P. Buchmann, K. Dätwyler, G. Sasso, and B. J. Van Zeghbroeck, "Nanometer sidewall lithography by resist silylation", J. Vac. Sci. Technol., Vol. B7, p 1756-1759, 1989.
13. Ch. S. Harder, B. J. Van Zeghbroeck, M. P. Kesler, H. P. Meier, P. Vettiger, D. J. Webb, and P. Wolf, "High-speed GaAs/AlGaAs optoelectronic devices for computer applications", IBM J. Res. Develop., Vol. 34, p 568-584, 1990.
14. T. N. Jackson, B. J. Van Zeghbroeck, G. Pepper, J. F. DeGelormo, T. Keuch, H. Meier, and P. Wolf, "Submicron-gate-length GaAs MESFETs", IBM J. Res. Develop., Vol. 34, p 495-505, 1990
15. Y.B. Gigase, Ch.S. Harder, M.P. Kesler, H.P. Meier, and B.J. Van Zeghbroeck, "Threshold reduction through photon recycling in semiconductor lasers", Appl. Phys. Lett., Vol. 57, No. 13, p 1310-1312, Sept. 24. 1990.
16. B. J. Van Zeghbroeck, "Low-temperature behavior of short-channel GaAs MESFETs", Cryogenics Vol. 30, p 1084-1087, December 1990.

17. Chu, Y. Gigase and B. J. Van Zeghbroeck, "All-electronic laser diode characterization through integration with a photodiode", IEEE Trans. Electr. Dev., Vol.38, p 2700, 1991.
18. Van Zeghbroeck, "Optical data-communication between Josephson-junction circuits and room-temperature electronics", IEEE Trans. Applied Superconductivity, Vol.3, No.1, pp 2881-2884, 1993.
19. A.K. Chu, Y. Gigase, H.Y. Lee, M.J. Hafich, G.Y. Robinson and B. Van Zeghbroeck, "Fabrication and characterization of an InGaAs/InP Photon Transport Transistor", IEEE Photonics Technology Letters, Vol. 4, pp. 454-456, April 1993.
20. H.C. Lee and B. Van Zeghbroeck, "A Novel High-Speed Silicon MSM Photodetector Operated at 830 nm wavelength", IEEE Electron Device Letters, Vol EDL-16, p 175-177, May,1995.
21. J. Pankove, S.S. Chang, M. Leksono and B. Van Zeghbroeck, "High-Power High-Temperature Heterobipolar Transistor with Gallium Nitride Emitter", MRS Internet J. Nitride Semicond. Res., Vol. 1, 39, June 1996.
22. Sarto and B. Van Zeghbroeck, "Photocurrents in a Metal-Semiconductor-Metal Photodetector", IEEE Journal of Quantum Electronics, Vol. 22, p 2188-2194, Dec. 1997.
23. J.T. Torvik, M. Leksono, J. I. Pankove, B. Van Zeghbroeck, H. M. Ng and T.D. Moustakas, "Electrical characterization of GaN/SiC n-p heterojunction diodes", Appl. Phys. Lett., Volt. 72, p 1371 - 1373, Mar. 1998.
24. R. Waters and B. Van Zeghbroeck, "Fowler-Nordheim tunneling of holes through thermally SiO₂ on p⁺ 6H-SiC", Applied Physics Letters, Vol. 73, pp 3692-3694, Dec 1998.
25. R. Waters, J. Patterson and B. Van Zeghbroeck, "Micro-Mechanical Optoelectronic Switch and Amplifier (MIMOSA)", J. Quantum Electr., Vol. 5, pp 33-35, Jan/Feb 1999.
26. J.T. Torvik, M. Leksono, J.I. Pankove, and B. Van Zeghbroeck, "A GaN/4H-SiC heterojunction bipolar transistor with operation up to 300°C", MRS Internet J. Nitride Semicond. Res., Vol. 4, 3, June 1999.
27. J.T. Torvik, J. I. Pankove, B. Van Zeghbroeck, "Comparison of GaN and 6H-SiC p-i-n photodetectors", ", IEEE Transactions on Electron Devices, Vol. 46, p 1326-1331, July 1999.
28. R. Waters and B. Van Zeghbroeck, "On Field Emission from a Semiconducting Substrate", Appl. Phys. Lett, Vol. 74, Oct 18, 1999.
29. R.L. Waters and B. Van Zeghbroeck, "Temperature-dependent tunneling through thermally grown SiO₂ on n-type 4H- and 6H-SiC", Appl. Phys. Lett, Vol. 76, No. 8, pp. 1039-1041, Feb. 21, 2000.
30. B. Van Zeghbroeck, S.S. Chang, R. Waters, J. Torvik and J. Pankove, "GaN/SiC HBT's and related issues", Solid State Electronics, Vol. 44, pp 265-270 February 2000.
31. J. Torvik, J.I. Pankove, M.W. Leksono, G. Eldridge and B. Van Zeghbroeck, "GaN/SiC Heterojunction Bipolar Transistors", Solid State Electronics, April 2000.
32. I. Perez-Wurfl, R. Krutsinger, J.T. Torvik and B. Van Zeghbroeck, 4H-SiC bipolar junction transistor with high current and power density, Solid State Electr., Vol. 47, 229-231, 2003.
33. Perez-Wurfl I, Torvik J, Van Zeghbroeck B, "Analysis of power dissipation and high temperature operation in 4H-SiC bipolar junction transistors with 4.9 MW/cm² power density handling ability", Material Science Forum 457-460: 1121-1124 Part 1&2 2004.
34. Zhao F, Perez I, Huang CF, Torvik J, Van Zeghbroeck B, "Analysis of transit times and minority carrier mobility in n-p-n 4H-SiC bipolar junction transistors", IEEE Trans. Electr. Dev. Vol 52 (12): 2541-2545 Dec. 2005.

Conference Proceedings

1. H. Jäckel, V. Graf, B. J. Van Zeghbroeck, P. Vettiger, and P. Wolf, "Ion-Implanted Submicron MESFET's with High Transconductance", Proc. International Symposium on Gallium Arsenide and Related Compounds, Las Vegas, 1986, pp 471-476.
2. B. J. Van Zeghbroeck, W. Patrick, H. Meier, P. Vettiger, and P. Wolf "High-Performance GaAs MESFET's", Proc. International Electron Devices Meeting, Los Angeles, pp 832-834, 1986.
3. W. Patrick, K. Dätwyler, B. J. Van Zeghbroeck, and P. Vettiger, "Technology for Submicron Recessed-Gate GaAs MESFETs on Thin MBE Layers using Electron Beam Lithography", Proc. 14th Intl. Conf. on GaAs and Related Compounds, Heraklion, Greece, 1987.
4. B. J. Van Zeghbroeck, Ch. Harder, J-M. Halbout, H. Jäckel, H. Meier, W. Patrick, P. Vettiger, and P. Wolf, "5.2GHz Monolithic GaAs Optoelectronic Receiver, High-Performance GaAs MESFET's", Proc. International Electron Devices Meeting, Washington, 1987, pp 229-232.
5. B. J. Van Zeghbroeck, "Analysis of Picosecond and Subpicosecond MSM Photodiodes with Very Low Bias Voltage", Proc. Device Research Conference, Boulder, 1988, p IIB-1.
6. B. J. Van Zeghbroeck, Ch. S. Harder, H. P. Meier and W. Walter, "Photon transport transistor", Proc. International Electron Device Meeting, Washington DC, p 543-546, 1989.
7. Y. Gigase, Ch. Harder, H. Meier and B. Van Zeghbroeck, "Threshold power reduction of GaAs-AlGaAs Ridge SQW-GRINSCH laser diodes through photon recycling", Proc. 12th IEEE international semiconductor laser conference, Davos Switzerland, Sept. 1990.
8. Y. Gigase, Ch. Harder and B. J. Van Zeghbroeck, "Monolithic optoelectronic circuit based on vertical integration of laser diodes and photodiodes", Late news paper at the IEEE LEOS summer topical meeting on integrated optoelectronics, Monterey CA, July 1990.
9. Chu, Y. Gigase and B. Van Zeghbroeck, "Gain collapse in the photon transport transistor (PTT) above lasing threshold", Optical Society of America, Proc. Topical meeting on Picosecond Electronics and Optoelectronics, Salt Lake, UTAH, March 13-15, 1991.
10. Chu, Y. Gigase and B. J. Van Zeghbroeck, "All-electronic laser diode characterization through integration with a photodiode", Proc. Device Research Conference, June 17-19, Boulder, CO 1991.
11. A.K. Chu, Y. Gigase, H.Y. Lee, M.J. Hafich, G.Y. Robinson and B. Van Zeghbroeck, "Fabrication and characterization of an InGaAs/InP Photon Transport Transistor", Proc. IEEE LEOS Summer topical meeting on Integrated Optoelectronics, pp79-80, Santa Barbara, CA, Aug. 1992
12. D.J. Blumenthal, J.R. Sauer, H. Lee, and B. Van Zeghbroeck, "A Packet-rate real-time reconfigurable photonic switch for computer interconnects", Proc. IEEE LEOS Summer topical meeting on Optical Multiple Access Networks, pp11-12, Santa Barbara, CA, Aug. 1992.
13. Van Zeghbroeck, "Optical data-communication between Josephson-junction circuits and room-temperature electronics", Proc. Appl. Supercond. Conf, Chicago, August 1992.
14. H. F. Jordan, A. R. Michelson, B. Van Zeghbroeck and I. Januar, "An integrated Optics Stored Program Computer", Invited paper OFC1, Proc. Topical Meeting on Optical Computing, 1993.

15. H. C. Lee and B. Van Zeghbroeck, "Metal-Semiconductor-Metal Photodiodes on Textured Silicon Membranes", Proc. Device Research Conference, Paper VIA-2, Boulder, CO, June 1994.
16. H. C. Lee and B. Van Zeghbroeck, "Light Trapping Textured Silicon Membranes for Photonic Applications", Proc. Electronic Materials Conference, Paper AE3, Boulder, CO, June 1994.
17. J. Pankove, S. S. Chang, H. C. Lee, R. J. Molnar, T. D. Moustakas and B. Van Zeghbroeck, "High-Temperature GaN/SiC Heterojunction Bipolar Transistor with High Gain", Proc. International Electron Devices Meeting, p 389-392, San Francisco, CA, Dec. 1994.
18. S. S. Chang, J. Pankove, M. Leksono and B. Van Zeghbroeck, "500° C operation of a GaN/SiC Heterojunction Bipolar Transistor", Proc. Device Research Conf, Paper IVB-5, Charlottesville, VA, June 1995.
19. A.K. Chu, H.C. Lee and B. Van Zeghbroeck, "A Novel Multi-functional Optoelectronic Device for Large Scale Integration: a Detector, an Electronic Transistor and a Laser Diode in One", Proc. IEEE/LEOS 1995 Topical Meeting on RF Optoelectronics, Paper FB2, Keystone, CO, Aug. 1995.
20. J. Pankove, S.S. Chang, M. Leksono and B. Van Zeghbroeck., "High-Temperature High-Gain GaN/SiC HBTs", Proc. 1st European Gallium Nitride Workshop, Rigi, Switzerland, June 1996.
21. J. Patterson and B. Van Zeghbroeck, "Fabrication and Analysis of Si/SiO₂ Micro-Mechanical Modulators", Proc. IEEE/LEOS 1996 Topical Meeting, Paper FA4, p 65-66, Keystone, CO, August 1996.
22. R. Waters and B. Van Zeghbroeck, "Fowler-Nordheim tunneling of holes through thermally SiO₂ on p+ 6H-SiC", Proc. Electr. Materials Conf., Paper, Charlottesville, VA, June 1998.
23. R. Waters, J. Patterson and B. Van Zeghbroeck, "Micro-Mechanical Optoelectronic Switch and Amplifier (MIMOSA)", Proc. IEEE/LEOS 1998 Topical Meeting, Paper, p, Monterey, CA, July 1998.
24. J. Torvik, J.I. Pankove, M.W. Leksono, G. Eldridge and B. Van Zeghbroeck, "GaN/SiC Heterojunction Bipolar Transistors", Proc. Workshop on wide bandgap bipolar devices, Paper 2-2, Panama City Beach, January 1999.
25. Van Zeghbroeck, "GaN/SiC HBTs and related topics", Proc. Workshop on wide bandgap bipolar devices, Paper 2-6, Panama City Beach, January 1999.
26. L.B. Rowland, G.T. Dunne, B. Van Zeghbroeck, J.T. Torvik and P.I. Pankove, "Materials challenges for p+ SiC-based GaN/SiC HBTs", Proc. Workshop on wide bandgap bipolar devices, Paper 2-6, Panama City Beach, January 1999.
27. R.L. Waters and B. Van Zeghbroeck, "Temperature dependence of the barrier height between SiO₂ and 4H-SiC/6H-SiC", Proc. Electron. Materials Conference, Santa Barbara, CA, July, 1999.
28. I. Perez-Wurfl, R. Krutsinger, J. Torvik and B. Van Zeghbroeck, SiC bipolar transistors for RF applications, Proc. 2001 International Semiconductor Device Research Symposium, Dec. 5-7, 2001, Washington DC.
29. Shahid H. Bokhari, Matthew A. Glaser, Harry F. Jordan, Yves Lansac, Jon R. Sauer and Bart Van Zeghbroeck, "Parallelizing a DNA Simulation Code for the Cray MTA-2," IEEE Computer Society Bioinformatics Conference, Stanford University, Palo Alto, CA, August 14-16, 2002, pp. 291-302.

30. Ivan Perez-Wurfl, Andrey Konstantinov, John Torvik and Bart Van Zeghbroeck, RF 4H-SiC Bipolar Junction Transistors, Proceedings of the Lester Eastman Conference, Aug. 6-8, Newark, DE, 2002.
31. Jon R. Sauer, Shahid H. Bokhari, Mathew A. Glaser, Harry F. Jordan, Yves Lansac, Bart Van Zeghbroeck, "Computational Bionanotechnology", SIAM Conference on Computational Science and Engineering, February 10-13, 2003.
32. I. Perez, J. Torvik and B. Van Zeghbroeck, Proceedings Device Research Conference, Salt Lake City, June 2003.
33. I. Perez, J. Torvik and B. Van Zeghbroeck, Proceedings International Compound Semiconductor Conference and Related Material, Lyon, France, October 2003.
34. C-F. Huang, I. Perez, F. Zhao, J. Torvik, R. Irwin, K. Torvik, F. Abrhaley, and B. Van Zeghbroeck, "SiC Bipolar Transistors for 215 W UHF Power Amplification Operated in Pulsed Class A Mode", Proc. Device Research Conference, Notre Dame, June 2004.
35. I. Perez-Wurfl, A. Goulakov, E. E. King, J. T. Torvik, S. C. Witzak, F. Zhao and B. Van Zeghbroeck, "Functional lifetime testing of 4H-SiC bipolar transistors in harsh environments", Proc. European Conference of Silicon Carbide and Related Materials, Bologna, Italy, Sept. 2004.
36. Feng Zhao, Ivan Perez-Wurfl, Chih-Fang Huang, John Torvik, and Bart Van Zeghbroeck, "First Demonstration of 4H-SiC RF Bipolar Junction Transistors on a Semi-insulating Substrate with f_T/f_{MAX} of 7/5.2 GHz", Proc. MTT Conference, Long Beach, CA, June 2005
37. Ivan Perez-Wurfl, Feng Zhao, Chih-Fang Huang, John Torvik, and Bart Van Zeghbroeck, "4H-SiC bipolar transistors with UHF and L-band operation", Proc. ICSCRM Conference, Pittsburg, PA, Sept. 2005
38. Ying Wang, Jin Hyoung Lee, Tomoko Borsa, Wounjhang Park and B. Van Zeghbroeck, "Photo-Response of Integrated Photonic Crystals-Photodiode Micro-Electro-Optic Filter", Proc. SPIE conference, San Diego, CA, July 2005

Publications in the IBM Technical Disclosure Bulletin

1. B. J. Van Zeghbroeck, "Subpicosecond Optical Sampling Gate", IBM Technical Disclosure Bulletin, Vol. 29, No. 5, pp 1968-1969, 1986.
2. C. Harder and B. J. Van Zeghbroeck, "Schottky Gate Cross-over", IBM Technical Disclosure Bulletin, Vol. 29, No. 7, p 2867, 1986.
3. C. Harder and B. J. Van Zeghbroeck, "Superlattice Hot Electron Transistor", IBM Technical Disclosure Bulletin, Vol. 29, No. 7, pp 2914-2915, 1986.
4. B. J. Van Zeghbroeck, "Superlattice Tailoring to obtain Devices with High Saturation Velocity", IBM Technical Disclosure Bulletin, Vol. 29, No. 7, pp 2931-2932, 1986.
5. B. J. Van Zeghbroeck, "Transferred-electron Static Memory Cell", IBM Technical Disclosure Bulletin, Vol. 28, No. 12, pp 5471-5472, 1986.
6. P. Buchmann and B. J. Van Zeghbroeck, "Passivated Recess-Gate Structure", IBM Technical Disclosure Bulletin, Vol. 30, No. 2, p 888, 1987.
7. C. Harder and B. J. Van Zeghbroeck, "Recessed Lateral Double-Heterojunction Bipolar Transistor", IBM Technical Disclosure Bulletin, Vol. 30, No. 6, pp 412-413, 1987.
8. R. F. Broom, H. P. Meier, and B. J. Van Zeghbroeck, "Electrically Transparent Etch-Stop Layer", IBM Technical Disclosure Bulletin, Vol. 30, No. 8, pp 270-271, 1988.

9. W. De Raedt and B. J. Van Zeghbroeck, "High Speed GaAs MESFET Sampling Circuit", IBM Technical Disclosure Bulletin, Vol. 30, No. 8, pp 284-286, 1988.
10. B. J. Van Zeghbroeck and P. Wolf, "One-Transistor Bistable Circuit", IBM Technical Disclosure Bulletin, Vol. 30, No. 10, pp 340-341, 1988.
11. B. J. Van Zeghbroeck, "Hybrid Static Memory Cell", IBM Technical Disclosure Bulletin, Vol. 31, No. 3, pp 204-205, 1988.
12. B. J. Van Zeghbroeck, "Superlattice Analog-to-Digital Convertor", IBM Technical Disclosure Bulletin, Vol. 31, No. 3, pp 257-258, 1988.
13. K. Dätwyler, G. Sasso, B. Van Zeghbroeck and P. Vettiger, "Partially-Supported Bridge Structure", IBM Technical Disclosure Bulletin, Vol. 31, No. 4, pp 266-267, 1988.
14. R. F. Broom and B. J. Van Zeghbroeck, "Static Memory Cell", IBM Technical Disclosure Bulletin, Vol. 31, No. 4, pp 271-272, 1988.
15. P. Heinzmann and B. J. Van Zeghbroeck, "Opto-electronic signal processing element", IBM Technical Disclosure Bulletin, Vol. 31, No. 9, pp 218-212, 1989.
16. B. J. Van Zeghbroeck, "Opto-electronic amplifier and logic element", IBM Technical Disclosure Bulletin, Vol. 31, No. 12, p 180, 1989.
17. C. S. Harder and B. J. Van Zeghbroeck, "Double sampling method", IBM Techn. Discl. Bulletin, Vol. 32, No. 3B, p 357, 1989.

Patents

1. US Patent 7,001,792: Issued Feb 21, 2006: Ultra-fast nucleic acid sequencing device and a method for making and using the same
2. US Patent 6,982,440: Issued Jan. 3, 2006: Silicon carbide semiconductor devices with a regrown contact layer
3. US Patent 6,764,907: Issued July 20, 2004: Method of fabricating self-aligned silicon carbide semiconductor devices
4. US Patent 6,413,792: Issued July 2, 2002: Ultra-fast Nucleic Acid sequencing devices and a method for making and using the same.
5. US Patent 5,600,130: Issued Feb. 4, 1997: Two-directional Optoelectronic Array Module.
6. US Patent 5,140,152: Issued Aug. 18, 1992: Full duplex optoelectronic device with integral emitter/detector pair.
7. US Patent 5,038,321: Issued Aug. 6, 1991: Erasable electro-optic storage disk, method of and apparatus for recording and reading data therefore.
8. US Patent 4,771,194: Issued Sept. 13, 1988: Sense amplifier for amplifying signals on a biased line.
9. European Patent: Filed July 7, 1989: Opto-electronic light emitting semiconductor device
10. European Patent: Filed March 24, 1986: Process for forming sidewalls