

BELFORD RESEARCH LTD DIRECTOR'S CV

Rona E. Belford B.Sc., Ph.D., C.Sci., C.Chem., MRSC, C.Eng., MIEE., MIEEE

belford@btconnect.com

www.laserdamage.co.uk www.belford-research.com

PATENTS

1. US Patent No. 6,514,836 B2 "Method of Producing Strained Microelectronic and/or Optical Integrated and Discrete Devices", Rona E. Belford, Feb 2003.
2. U.S. Patent, No. 6,455,397 B1, "Method of Producing Strained Microelectronic and/or Optical Integrated and Discrete Devices", Rona E. Belford, Sept 2002.
3. UK Patent GB 2 295 677 B, "A Method of Measuring the Concentration of Ions in a Solution", Rona E Belford 1998.
4. US Patent 5,725,754, "Method of Measuring the Concentration of Ions in Solution", Rona E Belford, 1998.
5. UK Patent GB 2 295 898 B "Solid State Blown Glass pH and Other Ion Sensor Systems", Rona E Belford and P C W Brehier, 1998.

CONSULTANCIES AND EDITORIAL EXPERIENCE

- Consultant in material damage pattern to Gooch and Housego 2017.
- Consultant in laser damage methodology to SELEX ES 2015.
- Consultant to SE on University based research project progress 2011.
- Consultant to Kigre, Inc., South Carolina for "Quantum Materials and IR Transmitting Materials"
- Consultant to Pentland Whiskey Research Limited, Edinburgh for "The Measurement of pH in Non-Aqueous Solutions".
- Consultant to the Wolfson Microelectronics Institute UK, for semiconductor material processing.
- Editorial work for "Sensors and Actuators B" Pub. Elsevier Sequoia SA, Lausanne, Switzerland.
- Editorial work for "Electronic Letters".
- Application Referee in the subject area of Electronic and Optical Amorphous Materials for the DTI/SERC; national government agency for allocating research funding.

EMPLOYMENT HISTORY

- 2008- Dr. Belford formed Belford Research Ltd.
- 1999- Dr. Belford formed Belford Research Inc. Straining semiconductors and developing their electronic and optical properties.
- 1997-99 Research Scientist, Integrated Data Systems, working with MIT on quantum features in Si.
- 1994-97 Kigre Inc. South Carolina USA; Headed research team producing non-linear materials.
- 1988-94 Lectureship, tenured, The Department of Physics, Napier University. Received "Honorary Fellow of the Faculty of Science and Engineering" at the University of Edinburgh

- 1986-88 Lectureship, Department of Electrical Engineering, University of Edinburgh.
1980-85 Research Engineer, Wolfson Microelectronics Institute, Department of Electrical Engineering: Headed a small group of engineers researching into solid-state sensors.

DEGREES

- 1986 PhD. Title of thesis: "Principles and Practice of Hybrid pH Sensors", Department of Electrical Engineering, University of Edinburgh.
1978 B.Sc. Chemistry 1st Class Honours, Heriot-Watt University, Edinburgh.

ACADEMIC AWARDS

- 2007 IEEE EDS Distinguished Lecturer
1988 International Society for Hybrid Microelectronics 1988 Prize for "Innovative Hybrid Devices", Educational Competition.
1977 & 1978 Slater-Price Prize for Physical Chemistry in final degree examination
1977 Degree examination exemptions for excellence in 3rd year Organic Chemistry, Physical Chemistry and Inorganic Chemistry
1977 Inorganic Chemistry Prize.
1976 Degree examination exemption for excellence in 2nd year Accountancy & Finance.

FEDERAL AWARDS

- Awarded the National Leadership Award of Honorary Chairman Business Advisory Council from the US National Congressional Committee 2004
Awarded the National Leadership Award of Honorary Chairman Business Advisory Council from the US National Congressional Committee 2003

AFFILIATIONS and LEARNED SOCIETIES

- Chartered Engineer and member of the Institution of Electrical Engineers (1990): Chartered Scientist (2006): Member of the Institute of Electrical and Electronic Engineers (2000) and member of the Electron Devices Society (2001)
Honorary Fellow of the College of Science and Engineering at The University of Edinburgh and has had this honour continuously 1988-2014.
The Royal Society of Chemistry; member, Chartered Chemist and Chartered Scientist: An original member of the Solid-State Chemistry group (1978):

SCHOLARSHIPS

- The RSE research scholarship 1993 was awarded for one year of research into the behaviour of ions in amorphous materials. Quantum glass research was performed in the USA. The scholarship program included physicists, chemists and ceramics engineers from Sweden, Germany and China.

CONFERENCE PRESENTATIONS

1. Rona E Belford, SPIE Photonics Brussels "Laser Damage Basics" Brussels April 2016.
2. Rona E Belford, "Laser Damage - a Balanced View", PHOTONEX Optical Engineering & Design Meeting III 16th October 2013.
3. Rona E Belford presentation to Cypress Inc. Dec 2006.
4. Rona E Belford presentations 1-4 Intel corporation April thru August 2006.
5. Sumant Sood and Rona E Belford, "Strained silicon via plasma enhanced dCTE bonding", International Symposium on Semiconductor Wafer Bonding, Cancun Mexico, Oct/ Nov 2006.
6. Rona E Belford, Qing Xu, Sumant Sood, Antonio Acosta, Alan Thrift, Jordan Zell, Lloyd Bosworth, "Novel Process Combining SOI and Strained Circuitry", 2006 IEEE International SOI Conference, New York, poster presentation, Oct 2-5 2006.
7. Sumant Sood and Rona E Belford, "Surface Activation Using Remote Plasma for a New Wafer Bonding Route to Strained-Si", 209th Electrochemical Society Meeting Denver, May 2006.
8. Rona E Belford, "No Strain, No Gain", **invited paper**, IEEE International Electron Device Materials Colloquium, Orlando, Feb 2006.
9. Rona E. Belford, Wei Zhao, Jim Potashnik, Qingmin Liu, and Alan Seabaugh, "Performance Augmented CMOS Using Back-End Uniaxial Strain" Device Research Conference, June 2002.
10. Rona E Belford, "Strained Si Compliant Substrates", **invited paper**, International Conference on Alternative Substrate Technology, Lake Tahoe Jan 2001.
11. T W Hard, Rona E Belford and A E Owen, "AC Measurements on Tin Oxide Gas Sensors", Butler Conference on Polar Solids", University of St. Andrews, Scotland, Dec 1995.
12. S Jiang, J D Myers, Rona E Belford, et al "Flashlamp Pumped Lasing of Ho:Germanium Oxide Glass at Room temperature", Advanced Solid State Lasers Ninth Topical Meeting, Salt Lake City, USA, 1994.
13. P C Brehier and Rona E Belford, "Thick Film pH Sensors", The Butler Postgraduate Meeting, University of St Andrews, Scotland, 1994.
14. S Jiang, J D Myers, Rona E Belford and Scott Hamlin, "Laser and Thermal Performance of a New Erbium Doped Phosphate Laser Glass", OE/LASE'94 Los Angeles, Cal, USA, 1994.
15. Rona E Belford "Optical and Photodissolution Phenomena In IR Glasses", **invited seminar** given at the Dept. of Physics, University of South Carolina USA, 1993.
16. Rona E Belford and A E Owen "Application of Chalcogenide Glasses in IR Diffraction Optics" Gordon Research Conference on "Optical Phenomena in Glass" at Tilton, New Hampshire USA 1992.
17. Rona E Belford "Novel Glasses for Sensor and Optical Thick-Film Devices" **invited paper** at The Solid Sensors Conference, University of Southampton, England, 1992.
18. E Hajto, Rona E Belford et al., "Electrical Properties of Silver Doped As-S Glass", ICALS 14th Conference in Garmisch-Partenkirchen, Germany 1991.
19. Rona E Belford, "Amorphous Semiconductors in Microelectronic Applications", **invited paper** at the Solid State Materials Conference, University of Aberdeen, Scotland, 1989.
20. E Hajto, Rona E Belford, P J S Ewen and A E Owen, "High Resolution Inorganic Photo-Resist Systems for Microlithography", ICAL's 13th and ICAST 1st Conferences North Carolina, USA, 1989.
21. Rona E Belford "Chalcogenide Glasses as High Resolution Resists", **invited seminar** given at the Dept. of Electrical Engineering, University of Western Australia, Perth, W. Australia, 1989.
22. E Hajto, P J S Ewen, Rona E Belford, J Hajto and A E Owen, "Optical Properties of Spin Coated Amorphous Chalcogenide Thin Films", ICALS 12th Conference, Prague, Czechoslovakia, 1987.
23. Rona E Belford and A P Firth, "Amorphous Chalcogenide Resists", **invited paper** at The Conference of Polymers in Microlithography, University of Stirling, Scotland, 1986.

24. Rona E Belford "A C Admittance Spectra of Hybrid Glass Electrodes", SERC Advanced Postgraduate Vacation School on Non-Crystalline Materials, University of Leicester, England, 1983.
25. Rona E Belford, R G Kelly and A E Owen, "Conduction and Contact Processes in Solid State pH Sensors", The European Conference of Sensors and their Applications", UMIST Manchester, England, 1983.

Publications of industrial sponsored research is restricted

MAGAZINE ARTICLES

1. Rona E Belford, "A New Slant on Strain", Web Exclusive **Featured Article**, Semiconductor International Magazine, 1st Oct 2006.
2. Rona E Belford, "Smart mechanical strain techniques to improve device performance", **Featured Article**, Semiconductor Manufacturing Magazine, Sep 2006.
3. Rona E Belford featured in "Silicon Takes the Strain", IEE Review **special report** on Microelectronics Dec 2003.

SELECTED REFEREED PUBLICATIONS

26. Rona E Belford and Sumant Sood, "Surface activation using remote plasma for silicon to quartz wafer bonding", *Microsystem Technologies*: Vol. 15(3), 407 (2009).
27. Rona E Belford, Q. Xu, A. Acosta, S. Sood and L. Lu "Anisotropic Mechanical Stress Route to Optimally Strained Metal Oxide Semiconductor Field Effect Transistors, Submitted to IEEE Trans 2007.
28. Rona E Belford and S. Sood "Surface Activation Using Remote Plasma for Hydrophilic Bonding at Elevated Temperature", *Electrochemical and Solid-State Letters*, Vol 10, (5) H145-H148, 2007.
29. Sumant Sood and Rona E Belford, "Strained silicon via plasma enhanced dCTE bonding", *ECS Transactions*, Vol. 3 (6), 99-106, (2006).
30. Rona E Belford, B. P. Guo, Q. Xu, S. Sood, A. A. Thrift, A. Teren, A. Acosta, L. A. Bosworth, and J. S. Zell 'Strain enhanced p-type metal oxide semiconductor field effect transistors'. *J. Appl. Phys.* 100, 064903 (2006).
31. Sumant Sood and Rona E Belford, "Surface Activation Using Remote Plasma for a New Wafer Bonding Route to Strained-Si", " *ECS Transactions*, Vol. 2 (4), 23-29, (2006).
32. Becca M. Haugerud, Mustayeen, B. Nayeem, Ramkumar Krithivasan, Yuan Lu, Chendong Zhu, John D. Cressler, Rona E. Belford, Alvin J. Joseph, "The effects of mechanical planar biaxial strain in Si/SiGe HBT BiCMOS technology" *Solid-State Electronics* 49 pp 986–990 2005. B. M. Haugerud, L. A. Bosworth and Rona E Belford, "Elevated-Temperature Electrical Characteristics of Mechanically Strained-Si Devices" *J. Appl. Phys.* Vol. 95, No. 1 pp 2792-2796, Mar 2004.
33. Wei Zhao, Jianli He, Rona E Belford, Lars-Erik Wernersson, and Alan Seabaugh, "Partially-Depleted SOI MOSFETs Under Uniaxial Tensile Strain" *IEEE Trans. Electron Devices*, Vol. 51, No. 3, pp 317-323, March 2004.
34. B. M. Haugerud, L. A. Bosworth and Rona E Belford, "Mechanically Induced Strain Enhancement of Metal Oxide Semiconductor Field Effect Transistors" *J. Appl. Phys.* Vol. 94, No.6 pp 4102-4107, 2003.

35. Rona E. Belford, Wei Zhao; J. Potashnik, Qingmin Liu and Alan Seabaugh, "Performance-augmented CMOS using back-end uniaxial strain" Device Research Conference, 2002, 60th DRC. 24-26 June 2002, Conference Digest Page(s): 41 - 42.
36. Rona E Belford, "Uniaxial, Tensile Strained-Si Devices", J. Elect. Mat., Vol. 30, No.7, 2001.
37. P C W Brehier and Rona E Belford, "Effects of Ion Migration and Electrolysis in Glass Electrode Fabrication" Anal. Proc. Vol. 32, pp 327-328, 1995.
38. Rona E Belford and P C W Brehier, "Thick-Film Reference Electrodes for Solid State pH Measurement", Anal. Proc. Vol. 32, pp 323-326, 1995.
39. S Jiang, J D Myers, D Rhonehouse, M J Myers, Rona E Belford and Scott Hamlin, "Laser and Thermal Performance of a New Erbium Doped Phosphate Laser Glass", SPIE, Vol. 2138, 1994.
40. Jiang, J D Myers, Rona E Belford, et al. "Flashlamp Pumped Lasing of Ho:Germanium Oxide Glass at Room Temperature", Advanced Solid State Lasers, Tech. Dig., OSA, Washington DC, pp 329-331, 1994.
41. E Hajto, P J S Ewen, Rona E Belford and A E Owen, "Interference Grating Fabrication in Spin Coated As₂S₃ Films", Thin Solid Films, 200, pp.229-237, 1991.
42. E Hajto, Rona E Belford, P J S Ewen and A E Owen, "Electrical Properties of Silver Doped As-S Glasses", JNCS, 137 and 138, pp.1039-1042, 1991.
43. Rona E Belford and A E Owen, "Interfacial Aspects of Glass", **Invited Chapter** in "Glasses and Glass-ceramics", Ch.9, pp.316-335, Ed. M H Lewis, Publ. Chap. & Hall, 1989.
44. Rona E Belford, E Hajto and A E Owen, "The Selective Removal of the Negative Photo Resist System Ag-As-S", Thin Solid Films, 173, 1989.
45. E Hajto, Rona E Belford, P J S Ewen and A E Owen, "Dry Etched High Resolution Positive and Negative Inorganic Photoresists", JNCS 115, pp.129-131, 1989.
46. Rona E Belford, R G Kelly and A E Owen, "Thick Film Devices", **Invited Chapter** in "Chemical Sensors", Chapter 11, pp.236-255, Ed. T E Edmonds, Publ. Blackie & Son, 1988.
47. Rona E Belford and A E Owen, "The Selective Removal of the Negative Photo Resist System Ag-As-S by a Dry Etch Plasma of Sulfur Gas", Patent App.No.8816978.4, 1988.
48. Rona E Belford and A E Owen, "Temperature Dependent AC Impedance Studies of Solid Glass to Metal Contacts in Solid State Glass pH Sensors", JNCS, Vol.92, No.1, pp.73-88, 1987.
49. Rona E Belford, A E Owen and R G Kelly, "Thick Film Hybrid pH Sensors", Sensors and Actuators, 11, pp.387-398, 1987.
50. S Reynolds and Rona E Belford, "Amorphous Electronic Materials and Their Applications" **Invited review** in "Physics in Technology", Vol.18, No.5, pp. 193-302, 1987.
51. E Hajto, P J S Ewen, Rona E Belford, J Hajto and A E Owen, "Optical Properties of Spin Coated Amorphous Chalcogenide Thin Films", JNCS, Vol. 97 & 98, pp.1191-1194, 1987.

RESEARCH PROGRAMS

- 2005-7 HQ0006-05-C-7110 Congressional Award Next-Again-Generation Radiation Hard CMOS.
- 2004-7 NSF SBIR Phase II: Ge-Free Strained Silicon Via Differential Thermal Coefficient of Expansion Bonding.
- 2003 DA972-03-C-0019 DARPA MTO BAA SPARWARSSYSCEN Research Contract: Novel Approach to Ultra-High-Speed, Fully Integrated Bipolar and Uni-polar Devices.
- 2003 HQ0006-03-C-0071 MDA Phase I: Strained GaN Device Technology Enhancements.
- NSF SBIR Phase I: Ge-Free Strained Silicon Via dTCE Bonding Differential Thermal Coefficient of Expansion Bonding.
- 2003 HQ00006-03-C-0029 MDA SBIR Phase I: Ge-Free Strained Silicon.
- 2002 DASG60-02-P-0108 MDA SBIR Phase I: Strain-Enhanced Tunnel Diode Technology.

- 2001 N00014-01-C-0164 ONR BAA Research Contract for research into Strained Si MOSFETs.
- 2001 DASG60-01-C-0039 BMDO, SBIR Phase II: Next-Again-Generation Radiation Hard CMOS.
- 2000 BMDO SBIR Phase I: Next-Again-Generation Radiation Hard CMOS.
- 1996 DAAL01-96-C-0064 ARMY Artillery Laser Ignition.
- 1995 DAAB07-95-M026 ARMY Laser Rangefinder Module.
- 1995 National Science Foundation SBIR Phase I: IR Ge-Glass Delivery Optics.
- 1994/5 Wolfson Foundation Research Grant for a Materials Deposition Station.
- 1993 Royal Society of Edinburgh Support Fellowship for one year.
- 1992-95 A Research Scholarship was won, up to sponsored by British Gas PLC., for a three year project on "AC Impedance Techniques for Solid State Gas Analysis".
- 1991-93 A Link Award for a two-year project on "Solid State Chemical Sensors". The funding bodies were SERC, DTI and Russell pH Ltd Fife, UK.