

## BELFORD RESEARCH LTD DIRECTOR'S CV

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

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### 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.  
1986-89 Lectureship, Dept of Electrical Engineering, University of Edinburgh. 1988 Lectureship, The Dept of Physics, Napier University.  
1988 Received "Honorary Fellow of the Faculty of Science and Engineering" The University of Edinburgh

### DEGREES

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

### 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.

### FEDERAL AWARDS

Awarded the National Leadership Award Chairman Business Advisory Council from the US National Congressional Committee 2003 and 2004

### 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 1978

## CONSULTANCIES AND EDITORIAL EXPERIENCE

- Consultant in material damage pattern to Gooch and Housego.
- Consultant in laser damage methodology to SELEX ES
- Consultant to SE on University based research project progress
- 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.

## WHITEPAPERS

- 2020 June: Whitepaper on High Power Laser Damage & Annealing RE Belford, K.R. Ross
- 2020 March: Whitepaper on High Power Pulsed and CW Laser Damage RE Belford, K.R. Ross and M. Duff.
- 2017 June: Whitepaper on High Power, High LIDT Laser Optics with Gooch and Housego.

## MAGAZINE ARTICLES

- 1.
2. Contributed to “Coating techniques push laser component limits” Electro Optics Magazine May 2018.
3. Rona E Belford, "A New Slant on Strain", Web Exclusive **Featured Article**, Semiconductor International Magazine, 1st Oct 2006.
4. Rona E Belford, "Smart mechanical strain techniques to improve device performance", **Featured Article**, Semiconductor Manufacturing Magazine, Sep 2006.
5. Rona E Belford featured in "Silicon Takes the Strain", IEE Review **special report** on Microelectronics Dec 2003.

## SELERCTED REFEREED PUBLICATIONS

1. Rona E Belford and Sumant Sood, "Surface activation using remote plasma for silicon to quartz wafer bonding", Microsystem Technologies: Vol. 15(3), 407 (2009).
2. 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.
3. 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.
4. Sumant Sood and Rona E Belford, "Strained silicon via plasma enhanced dCTE bonding”, ECS Transactions, Vol. 3 (6), 99-106, (2006).

5. 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).
6. 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).
7. 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.
8. 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.
9. 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.
10. 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.
11. Rona E Belford, "Uniaxial, Tensile Strained-Si Devices", *J. Elect. Mat.*, Vol. 30, No.7, 2001.
12. 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.
13. 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.
14. 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.
15. 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.
16. E Hajto, P J S Ewen, Rona E Belford and A E Owen, "Interference Grating Fabrication in Spin Coated As<sub>2</sub>S<sub>3</sub> Films", *Thin Solid Films*, 200, pp.229-237, 1991.
17. 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.
18. 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.
19. 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.
20. 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.
21. 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.
22. 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.
23. 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.
24. Rona E Belford, A E Owen and R G Kelly, "Thick Film Hybrid pH Sensors", *Sensors and Actuators*, 11, pp.387-398, 1987.
25. 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.

26. 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.

## CONFERENCE PRESENTATIONS

27. Rona E Belford, SPIE Photonics Brussels "Laser Damage Basics" Brussels April 2016.
28. Rona E Belford, "Laser Damage - a Balanced View", PHOTONEX Optical Engineering & Design Meeting III 16th October 2013.
29. Rona E Belford presentation to Cypress Inc. Dec 2006.
30. Rona E Belford presentations 1-4 Intel corporation April thru August 2006.
31. Sumant Sood and Rona E Belford, "Strained silicon via plasma enhanced dCTE bonding", International Symposium on Semiconductor Wafer Bonding, Cancun Mexico, Oct/ Nov 2006.
32. 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.
33. Sumant Sood and Rona E Belford, "Surface Activation Using Remote Plasma for a New Wafer Bonding Route to Strained-Si", 209<sup>th</sup> Electrochemical Society Meeting Denver, May 2006.
34. Rona E Belford, "No Strain, No Gain", **invited paper**, IEEE International Electron Device Materials Colloquium, Orlando, Feb 2006.
35. 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.
36. Rona E Belford, "Strained Si Compliant Substrates", **invited paper**, International Conference on Alternative Substrate Technology, Lake Tahoe Jan 2001.
37. 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.
38. 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.
39. P C Brehier and Rona E Belford, "Thick Film pH Sensors", The Butler Postgraduate Meeting, University of St Andrews, Scotland, 1994.
40. 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.
41. Rona E Belford "Optical and Photodissolution Phenomena In IR Glasses", **invited seminar** given at the Dept. of Physics, University of South Carolina USA, 1993.
42. 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.
43. Rona E Belford "Novel Glasses for Sensor and Optical Thick-Film Devices" **invited paper** at The Solid Sensors Conference, University of Southampton, England, 1992.
44. E Hajto, Rona E Belford et al., "Electrical Properties of Silver Doped As-S Glass", ICALS 14th Conference in Garmisch-Partenkirchen, Germany 1991.
45. Rona E Belford, "Amorphous Semiconductors in Microelectronic Applications", **invited paper** at the Solid State Materials Conference, University of Aberdeen, Scotland, 1989.
46. 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.
47. 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.

48. 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.
49. Rona E Belford and A P Firth, "Amorphous Chalcogenide Resists", **invited paper** at The Conference of Polymers in Microlithography, University of Stirling, Scotland, 1986.
50. 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.
51. 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

## **CONTRACTS AWARDED**

- 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.