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Research

Research Interests

Innovation

- Chemical process monitoring using fibre optic sensor systems
- Structural integrity monitoring
- Clean and energy efficient manufacture of composites
- Self-sensing composites
- Multi-functional sensors
- Synthesis and characterisation of novel materials
- Smarter materials

Current Research

- Next generation filament winding (2010-2013): TSB
- Environmentally friendly and energy efficient pultrusion (2009-2012): EPSRC/TSB
- Energy efficient and environmentally friendly recycling of composites (2009-2011): TSB
- International collaboration (2009-2012): Royal Society
- International collaboration (2010-2012): Royal Academy of Engineering

Recently Completed Research Projects

- Self-sensing composites (2005-2008): EPSRC
- Advanced composites life assessment and integrity management (2005-2008): EPSRC/DTI
- Simultaneous thermal and spectral analyses of polymers: (2001-2005): EPSRC
- Clean filament winding: (2003-2006): EPSRC/DTI
- A novel acoustic emission sensor for the electrical industry (FOASMIE): 2002-2006: DTI
- EPSRC grants: **http://gow.epsrc.ac.uk/NGBOViewPerson.aspx?PersonId=5176 (http://gow.epsrc.ac.uk/NGBOViewPerson.aspx?PersonId=5176)**

Publications

1. **Novel sensor systems (#1)**
2. **Chemical process monitoring (#2)**
3. **Structural integrity monitoring (#3)**
4. **Clean processing of composites (#4)**
5. **Novel materials (#5)**
6. **Combined (hyphenated) analytical techniques (#6)**
7. **Fatigue of composites (#7)**

1. Novel sensor systems

1.1 "A novel multifunctional fibre optic sensor", Mahendran, R. S., Machavaram, V. R., Wang, L., Burns, J. M., Harris, D., Kukureka, S. N., Fernando, G. F., *SPIE/Smart Structures and Materials & Non-destructive Evaluation and Health Monitoring 2009: Smart Sensor Phenomena, Technology, Networks, and Systems , edited by Norbert G. Meyendorf, Kara J. Peters, Wolfgang Ecke, Proceedings of SPIE Vol. 7293, 72930C, March 2009, San Diego, CA, USA. (2009).*, edited by Norbert G. Meyendorf, Kara J. Peters, Wolfgang Ecke, Proceedings of SPIE Vol. 7293, 72930C, March 2009, San Diego, CA, USA. (2009).

1.2 “Characterisation of the cross-linking process in an E-glass fibre/epoxy composite using evanescent wave spectroscopy”, Wang, L., Pandita, S. D., Machavaram, V. R., Malik, S. A., Harris, D. and Fernando, G. F., Composite Science and Technology,69, 2069, (2009).

1.3 "Self-sensing, self-healing, and crack-arrestor composites", Harris, D., Mahendran, R. S., Brooks, D., Al-Khodairi, F. A., Machavaram, V. R., Reynolds, P., Wang, L., Pandita, S. D., Paget, M., Wedderburn, J., Malik, S. A., Ojo, S. O., Kukureka, S. N., Fernando, G. F., *SPIE/Smart Structures and Materials & Non-destructive Evaluation and Health Monitoring 2009: Smart Sensor Phenomena, Technology, Networks, and Systems, edited by Norbert G. Meyendorf, Kara J. Peters, Wolfgang Ecke, Vol.*

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1.4 “A multi-purpose optical fibre sensor design for fibre reinforced composite materials”, Fernando, G. F., Liu, T., Crosby, P. A., Doyle, C., Martin, A., Brooks, D., Ralph, B. & Badcock, R. A., Journal of Measurement Science and Technology, **8**, 1065-1079, (1997).

1.5 “A novel optical-fibre based vibration sensor”, Doyle, C. and Fernando, G. F., Journal of Materials Science Letters, **16**, 1104-1105, (1997).

1.6 “A novel optical fibre-based strain sensor”, Martin, A., Badcock, R., Nightingale, C. & Fernando, G. F., Photonics Technology Letters, IEEE, 9, No. 7, 982-984, (1997).

1.7 "In-situ damage detection using self-sensing composites", Malik, S. A., Wang, L., Mahendran, R. S., Harris, D., Ojo, S. O., Collins, D., Paget, M., Pandita, S. D., Machavaram, V. R., and Fernando, G. F., Eds. Tomizuka M., Proceedings of SPIE/Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems, Vol. 7292, 729204, March 2009, San Diego CA, USA. (2009).

1.8 “Fabrication of intrinsic fibre Fabry-Perot cavities in silica optical fibres via F2- laser ablation”, Machavaram, V. R., Badcock, R. A. and Fernando, G. F., Measurement Science and Technology, 18 (3), 928-934, (2007).

1.9 “Linear location of acoustic emission using a pair of novel fibre optic sensors”,Chen, R. S., Bradshaw, T., Burns, J., Cole, P., Jarman, P., Pedder, D., Theobald, R. and Fernando, G. F., Measurement Science and Technology, 17 (8), 2313-2318, (2006).

1.10 “Fabrication of intrinsic Fabry-Perot sensors in silica fibres using hydrofluoric acid etching”, Machavaram, V. R., Badcock, R. A. and Fernando, G. F., Sensors and Actuators, A- Physical, 138 (1), 248-260, (2007).

1.11 “Fibre optic dilato-spectroscopic sensor: Simultaneous thermal, spectral and physical analyses of materials”, Degamber, B. and Fernando, G. F., Journal of Smart Materials and Structures, 15 (4): 1054-1062, (2006).

1.12 Degamber, B. and Fernando, G. F., “Microwave processing of thermosets: non-contact cure monitoring and fibre optic temperature sensors”, Journal of Plastics, Rubber and Composites, Vol. 32, No. 8/9, p327-333, (2003).

1.13 "In-situ cure monitoring using optical fibre sensors - a comparative study", Powell, G. R., Crosby, P. A., Fernando, G. F., Spooncer, R. C., France, C. M. & Waters, D. M. Journal of Smart Materials and Structures, **7**, 557-568, (1998).

1.14 “Simultaneous strain and temperature measurements using a multiplexed fibre Bragg grating sensor and an extrinsic Fabry-Perot sensor”, Liu, T., Wu, M., Fernando, G. F., Rao, Y. J., Jackson, D. A., Zhang, L. & Bennion, I., , Journal of Smart Structures and Materials, **7**, 550-556, (1998).

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1.17 “Simultaneous strain and temperature measurements in composites using an extrinsic Fabry-Perot sensor and a rare-earth doped fibre”, Liu, T., Fernando, G. F., Zhang, Z. and Grattan, K. T. V., Sensors and Actuators-A Physical, Vol. 80, No. 3, 208-215, 2000.

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1.19 "An intensity based optical fibre sensor for fatigue damage detection in advanced fibre reinforced composites", Badcock, R. A. and Fernando, G. F., Journal of Smart Materials and Structures, **4**, 223-230, (1995).

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2. Chemical process monitoring

2.1 “Process monitoring and damage detection using optical fibre sensors”, Harris, D., Machavaram, V. R. and Fernando, G. F., Chapter 14. Management, recycling and reuse of waste composites, Edited by V. Goodship, Woodhead Publishing Limited. ISBN 978-1-84569-462-3. (2010).

2.2 "The Application of Optical Fibre Sensors In Advanced Fibre Reinforced Composites: Chapter 3 - Cure Monitoring",Crosby, P. A. and Fernando, G. F., Optical Fibre Sensor Technology, Volume III, Edited by K. T. V. Grattan and B. T. Meggitt. Publisher: Kluwer Academic Publishers. ISBN 0412825708. (1999).

2.3 “Fibre optic sensor design for chemical process and environmental monitoring”, Mahendran, R. S., Wang, L., Machavaram, V. R., Chen, R., Kukureka, S. N. and Fernando, G. F., Special Issue of Optics and Laser Engineering, 47, 1069, (2009).

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3. Structural Integrity Monitoring

3.1 “Simultaneous acquisition of data on refractive index, strain, temperature and cross-linking kinetics”, Harris, D. and Fernando, G. F., International Conference on Composite Materials, ICCM-17, Edinburgh July 27-31, (2009).

3.2 "Monitoring and modeling the diffusion profile in a thermosetting resin", Mahendran, R. S., Chen, R., Kukureka, S. N., Fernando, G. F., *SPIE/Smart Structures and Materials & Non-destructive Evaluation and Health Monitoring 2009: Smart Sensor Phenomena, Technology, Networks, and Systems*, edited by Norbert G. Meyendorf, Kara J. Peters, Wolfgang Ecke, Proceedings of SPIE Vol. 7293, 729319, March 2009, San Diego, CA, USA. (2009).

3.3 "Finite element modelling of fibre Bragg grating sensors and experimental validation",Malik, S. A., Mahendran, R. S., Harris, D., Paget, M., Pandita, S. D., Machavaram, V. R., Collins, D., Burns, J. M., Wang, L. and Fernando, G. F. Eds. Tomizuka M., Proceedings of SPIE/Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems, Vol. 7292, 72921V, March 2009, San Diego CA, USA. (2009).

3.4 “Investigation of strain transfer to a sensor protection system embedded in concrete using finite element analysis”, Hameed, A., Fernando, G. F., Hetherington, J. G., Brown, R. D., Leng, J. and Barnes, R. A., Materials and Structures, Vol. 35, pp 557-563, (2002).

3.5 “Optical fibre sensors for structural health monitoring of concrete: Part 1: Sensor design, modelling and protection systems”, Fernando, G. F., Hameed, A., Tetlow, J., Winter, D., Leng, J., Barnes, R., Mays, J. and Kister, G., Journal of Structural Health Monitoring, Vol. 2 (2), 123-135, (2003).

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4. Clean processing of Composites

4.1 “Clean and environmentally wet-filament winding”, Shotton-Gale, N., Harris, D., Pandita, S. D., Paget, AM. A., Allen, J. A. and Fernando, G. F., Chapter 13. Management, recycling and reuse of waste composites, Edited by V. Goodship, Woodhead Publishing Limited. ISBN 978-1-84569-462-3. (2010).

4.2 “Lateral Spreading of a Fibre Bundle via Mechanical Means”, Irfan, M. S., Machavaram, V. R., Mahendran, R. S., Shotton-Gale, N., Wait, C.F, Paget, M. A., Hudson, M. And Fernando, G. F., Journal of Composite Materials, (2011). *in-press*.

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4.5 “Novel Pre-stressing Methodology for Autoclave Processing of Composites: Fabrication and Mechanical Performance"Krishnamurthy, S., Badcock, R. A., Hameed, A. and Fernando, G. F., SAMPE 2005/Long Beach, May 1-5, Long Beach, CA. USA. (2005).

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5. Novel materials

5.1 Editorial: Special Issue on Smart Materials and Systems, Fernando, G. F., Proceedings of the Institute of Mechanical Engineers, Part G, Journal of Aerospace Engineering, 221, (G4): III-V, (2007).

5.2 “Synthesis of azobenzene-based polymers and the In-situ characterisation of their photoviscosity effects”, Moniruzzaman, M., Sabey, C., Fernando, G. F., Macromolecules, 37, (7): 2572-2577, (2004).

5.3 “Synthesis and characterization of azobenzene and acrylamide based photo-responsive copolymers and gel”,Moniruzzaman, M., Fernando, G. F. and Talbot, J. D., J. Polymer Science: Part A: Polymer Chemistry, Vol. 42, 2886-2896, (2004).

5.4 “The use of 1H NMR and UV-VIS measurements for quantitative determination of trans/cis isomerisation of a photo-responsive monomer and its copolymer”, Moniruzzaman, M., Talbot, J. D., Sabey, C. J. and Fernando, G. F., Journal of Applied Polymer Science, 100, (2), pp 1103-1112, (2006)

5.5 “Investigation of reversible photo-mechanical properties of azobenzene-based polymer films by nano-indentation”, Moniruzzaman, M., Zioupos, P. and Fernando, G.F., Scripta Meterialia, 54 (2), PP 257-261, (2006).

5.6 “Self-sensing E-glass fibres”, Kister, G., Wang, L., Ralph, B. and Fernando, G. F., Optical Materials, 21, 713-727, (2003).

5.7 “Self-sensing fibre reinforced composites: sol-gel-based claddings”, Wang, L., Kister, G., Ralph, B. and Fernando, G. F., Journal of Smart Materials and Structures, Vol 13, 73-81, (2004).

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6. Combined (hyphenated) analytical techniques

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6.3 “The development of a hyphenated analytical technique for the measurement of refractive index, temperature and cross-linking kinetics”, Harris, D. and Fernando, G. F., *in-preparation.*

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7. Fatigue of composites

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