

AINSE Gold Medal Awards for Postgraduate Students - John Daniels



Assoc Prof Trevor Finlayson, John's supervisor, John Daniels, AINSE President 2007/08 Prof Brian O'Connor

John Daniels' PhD thesis entitled "Relaxation and Microstructural Studies in Ferroelectrics" was submitted for examination in mid-January, 2007, which will be just a little short of the minimum time of candidature since his commencement of post-graduate studies on 27 January, 2004.

During the first year of his postgraduate research he designed and commissioned a facility at the Lucas Heights Research Reactor to enable time-dependent, neutron-scattering studies of ferroelectric materials in response to applied electric fields, to be undertaken. This work demonstrated his skills as an experimental researcher in both hardware and software design, and an enthusiasm to develop a new experimental technique, a characteristic not often found amongst current postgraduate students under constant pressure to complete their degrees as quickly as possible. The stroboscopic neutron scattering facility was developed on the two-axis diffractometer, now commonly known as "The Australian Strain Scanner" (TASS) and the success of this phase of John's research project was evident in the Bragg Institute Scientific Highlight - 01/2005 entitled "Time-Resolved Electric-Field Neutron-Diffraction Experiments in the Microsecond Range.

http://www.ansto.gov.au/ansto/bragg/highlights/2005_01_daniels.html

A paper on this experimental development was presented at the 16th National Congress of the Australian Institute of Physics in February, 2005. It is a noteworthy development from Mr Daniels' work in this area that stroboscopic techniques will be available on some of the new instruments at the OPAL Research Reactor, to be commissioned through 2007.

The model material which had been suggested to Mr Daniels for study using stroboscopic techniques was the interesting ferroelectric, triglycine sulphate (TGS), and to complement the experimental facility on TASS to enable TGS to be studied in the vicinity of its ferroelectric Curie temperature (approximately 49°C), he designed and built a most inexpensive, variable-temperature stage for the goniometer, utilising "a used coke can" and a Peltier Cooler/Heater. The time dependence of the elastic scattering from TGS under the influence of an electric field and as a function of temperature in the vicinity of the Curie temperature have been studied and these results are the topic of three publications. In addition, this research was featured in a Monash Newline article released on the Monash University website in June, 2005 ("Better infra-red detectors possible")

<http://www.monash.edu.au/news/newslines/story/476>).

An original aim of the initial project was to examine the time-dependence of diffuse scattering from TGS. While no instrument at HIFAR was appropriate for such studies, successful proposals were made for beam time at the PUMA triple-axis instrument on the new FRM2 Research Reactor in Munich (with the generosity of the research group of Prof. Dr. Götz Eckold, University of Göttingen, Germany) and also at beamline ID15A at the European Synchrotron Research Facility (ESRF), Grenoble, France. Unfortunately, neither of these experiments revealed the diffuse scattering from TGS which had been suggested in some early literature on this material.

Following Mr Daniels' successful stroboscopic facility development, he was approached by a researcher from the University of New South Wales, through the AINSE network, to collaborate in a project applying the technique to studies of other ferroelectric systems, namely the actuator material, lead zirconate titanate (PZT) and the relaxor systems based on the mixed niobate-titanates, lead zinc niobate - lead titanate (PZN-xPT) and lead magnesium niobate - lead titanate (PMN-xPT). This research has involved the use of the facilities he developed on TASS, the High Resolution Powder Diffractometer (HRPD) at HIFAR as well as synchrotron X-ray facilities at the Advanced Photon Source (APS) in Chicago. Mr Daniels' scientific contribution to this collaborative research has been most significant and it will comprise two significant sections of his PhD thesis. It has resulted in five peer-reviewed publications (either accepted or submitted), another at an advanced stage of preparation, as well as a number of conference presentations.

Other notable achievements from Mr Daniels' research progress have been a most successful BSc (Hons) project in which he applied both dynamic elastic modulus and high-resolution neutron powder diffraction to examine phase transitions in the mixed perovskite system, $\text{Ca}_{1-x}\text{Sr}_x\text{TiO}_3$, (resulting in two publications and an associated paper arising from his developmental work to automate the dynamic modulus technique), preliminary research to characterise his TGS crystals using the 2TanA single-crystal neutron facility at HIFAR and the single-crystal X-ray diffractometer in the School of Chemistry at Monash University, (resulting in a publication) and to be awarded a post-graduate student prize for his poster presented to the 2nd Australian Research Network for Advanced Materials Annual Workshop (ARNAM 2006) held in Brisbane in June, 2006. He was the recipient of the 2003 J.J. McNeill prize awarded to the best BSc (Hons) student in the Department (now School) of Physics at Monash University and an AINSE Post-graduate Award in July, 2004, to supplement his Australian Postgraduate Award in January, 2004. His current schedule for the completion of his PhD thesis is slightly less than the minimum time for candidature is in part motivated by the fact that he will take up a post-doctoral research position at beamline ID15 at the European Synchrotron Research Facility (ESRF) in Grenoble, France, on 20 January, 2007, with research plans to continue time-resolved diffraction studies of advanced materials.

Assistance from the Australian Nuclear Science and Technology Organisation (ANSTO) Sub-Project Grant 0165P-6, and AINSE Project Grants 03150 and 04051 and a postgraduate research award which enabled the initial research on TGS to be undertaken are acknowledged. Mr Daniels' research was supervised by [Associate Professor Trevor Finlayson](#) of the School of Physics, Dr. Andrew Studer, The Bragg Institute, ANSTO and, in part, by Dr. Mark Hagen, formerly of The Bragg Institute but now at The Spallation Neutron Source, Oak Ridge National Laboratory, Oak Ridge, Tenn., USA.

Bibliography

Peer-reviewed Papers

1. Daniels, J.D., Elcombe, M.M., Finlayson, T.R. and Vance, E.R., , A.E., Finlayson, T.R., Leckey, R. and Riley, J., 'Phase Transformations in the $\text{Ca}_{1-x}\text{Sr}_x\text{TiO}_3$ Perovskite System' Proceedings of the 28th Annual A&NZIP Condensed Matter and Materials Meeting ed. N. Savvides (ISBN 0-643-09171-8) (Australian Institute of Physics, 2004) (http://www.aip.org.au/wagga2004/WP34_Daniels.pdf).*
2. Daniels, J.E., Studer, A.J., Finlayson, T.R. and Hagen, M.E., 'Development of a New Instrument to Observe Time-resolved Neutron Diffraction Intensities in Association with Phase Transitions' in Physics for the Nation (Proceedings of 16th National Congress of the Australian Institute of Physics) (Canberra, A.C.T. Australia) 31 January – 4 February, 2005. ed. M. Colla, ISBN 0-9598064-8-2 (Australian Institute of Physics, 2005) Paper No. MOC 34.
3. Daniels, J.E., Piltz, R., Hagen, M.E. and Finlayson, T.R., 'Neutron Diffraction Studies of the Ferroelectric/Paraelectric Transition in Triglycine Sulphate' in Physics for the Nation (Proceedings of 16th National Congress of the Australian Institute of Physics) (Canberra, A.C.T. Australia) 31 January – 4 February, 2005. ed. M. Colla, ISBN 0-9598064-8-2 (Australian Institute of Physics, 2005) Paper No. PTU 36.
4. Daniels, J.E., Finlayson, T.R., Studer, A.J. and Hagen, M.E., 'Time-resolved Neutron Diffraction Studies: The Ferroelectric Transition in Triglycine Sulphate' Proceedings of the 30th Annual A&NZIP Condensed Matter and Materials Meeting ed. M. Avdeev (ISBN 1-92079-09-4) (Australian Institute of Physics, 2004) (http://www.aip.org.au/wagga2006/WP49_Finlayson.pdf).
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7. Daniels, J.E., Finlayson, T.R., Studer, A.J. and Hagen, M.E., 'Time Resolved Neutron Diffraction Studies of Triglycine Sulphate near the Ferroelectric Transition during the Application of High-Voltage Electric Fields' Physica B (2006) (in press). (accepted 16/12/05)
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13. Daniels, J.E. and Finlayson, T.R., 'Automated Apparatus for Dynamical Mechanical Analysis using the Piezoelectric Ultrasonic Composite Oscillator Technique' J. Phys. D: Appl. Phys. (2006) (submitted 29 August, 2006) (revised and resubmitted 11 October, 2006).

Conference Papers (Presenter underlined)

1. 'Phase Transformations in the Ca_{1-x}Sr_xTiO₃ Perovskite System' J.E. Daniels, M.M. Elcombe, T.R. Finlayson and E.R. Vance. 28th Annual A & NZIP Condensed Matter and Materials Meeting (Wagga Wagga, N.S.W.) 4 - 7 February, 2004. (Paper WP34)*
2. 'Time-resolved Studies of Neutron Diffraction Intensities in Association with Phase Transitions' John Daniels, Trevor Finlayson, Andrew Studer and Mark Hagen. 4th AINSE Neutron Scattering Symposium and Workshop, Lucas Heights, N.S.W. (13-15 December, 2004)
3. 'Neutron Diffraction Studies of the Ferroelectric/Paraelectric Transition in Triglycine Sulphate' John Daniels, Ross Piltz, Mark Hagen and Trevor Finlayson. 4th AINSE Neutron Scattering Symposium and Workshop, Lucas Heights, N.S.W. (13-15 December, 2004)
4. 'Development of a New Instrument to Observe Time-resolved Neutron Diffraction Intensities in Association with Phase Transitions' J.E. Daniels, A.J. Studer, T.R. Finlayson and M.E. Hagen. 16th National Congress of the Australian Institute of Physics (Canberra, A.C.T.) 31 January – 4 February, 2005. (Paper No. MOC 34)
5. 'Neutron Diffraction Studies of the Ferroelectric/Paraelectric Transition in Triglycine Sulphate' J.E. Daniels, R. Piltz, M.E. Hagen and T.R. Finlayson. 16th National Congress of the Australian Institute of Physics (Canberra, A.C.T.) 31 January – 4 February, 2005. (Paper No. PTU 86)
6. 'Time Resolved Studies near the Ferroelectric Transition in Triglycine Sulphate' J.E. Daniels, M.E. Hagen, A.J. Studer and T.R. Finlayson. International Meeting on Ferroelectrics (IMF11) (Cataras del Iguazu, Brazil) 5-9 September, 2005.
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8. 'Neutron Diffraction Study of Polycrystalline Ca_{1-x}Sr_xTiO₃ Mixed Perovskite Materials' J.E. Daniels, M.M. Elcombe, T.R. Finlayson and E.R. Vance. International Conference on Neutron Scattering (Sydney, Australia) 27 November – 2 December, 2005. (Paper T33)*
9. 'Intrinsic and Extrinsic Contributions to the Piezoelectric Effect in Soft Lead Zirconium Titanate (PZT) Ceramics by Time-Resolved Neutron Diffraction' J.L. Jones, J.E. Daniels, A.J. Studer, M. Hoffmann and T.R. Finlayson. International Conference on Neutron Scattering (Sydney, Australia) 27 November – 2 December, 2005. (Paper T27)

10. `Time-resolved Neutron Diffraction Studies: The Ferroelectric Transition in Triglycine Sulphate' J.E. Daniels, T.R. Finlayson, A.J. Studer and M.E. Hagen. 30th Annual A & NZIP Condensed Matter and Materials Meeting (Wagga Wagga, N.S.W.) 7 - 10 February, 2006. (Paper WP49)
11. `Time-resolved Studies of Ferroelectric Materials during the Application of Electric Fields' J.E. Daniels, T.R. Finlayson, J.L. Jones and A.J. Studer. 2nd Australian Research Network for Advanced Materials Annual Workshop (ARNAM 2006) (Brisbane, Queensland) 28-30 June, 2006. (Poster Paper)
12. `Advances in the Characterisation of Domain Switching in Ferroelectric Ceramics' J.L. Jones, J.E. Daniels and E. Üstündag. European Powder Diffraction Conference (Geneva, Switzerland) 1 – 4 September, 2006.
13. `Structural Characterization of Ferroelectric Materials During Dynamic Electrical Loading' J.E. Daniels, T.R. Finlayson, J.L. Jones and A.J. Studer. Fall 2006 Meeting of the Materials Research Society (Boston, U.S.A.) 27 November – 1 December, 2006, Symposium T: Ferroelectrics and Multiferroics (Paper T8.5).
14. `Time-resolved Studies of Ferroelectric Materials using Neutron Stroboscopic Techniques during the Application of Electric Fields' J.E. Daniels, T.R. Finlayson, A.J. Studer and J.L. Jones. 17th National Congress of the Australian Institute of Physics (Brisbane, Q'ld) 3 – 8 December, 2006. (Presentation No. WC0325)

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