

THOMAS B. SHIELL

ACADEMIC QUALIFICATIONS

PhD

The Australian National University, Research School of Physics and Engineering
October 2014 –September 2018 (submitted)
Thesis titled, “The high pressure behaviour of glassy carbon”

MSc (physics)

The University of Melbourne, School of Physics
February 2012 – November 2013
Thesis title, “The fabrication and electrical characterization of polycrystalline
graphene transistors operating in atmosphere”

BSc (physics)

The University of Melbourne, School of Physics
February 2009 – November 2011

ACADEMIC EMPLOYMENT

POSTDOCTORAL RESEARCHER, RMIT UNIVERSITY

Joint supervisors: Prof. Dougal McCulloch and Prof. Jodie Bradby
October 2018 - present

Position description: Assisting with the implementation and development of
high pressure equipment and experiments at RMIT University, and receiving
practical training on scanning and transmission electron microscopes.

LABORATORY DEMONSTRATING, THE AUSTRALIAN NATIONAL UNIVERSITY

Subject: Condensed matter physics (PHYS3032)
2015 - 2018
Course convener: Prof. Robert G. Elliman

LABORATORY DEMONSTRATING, THE UNIVERSITY OF MELBOURNE

Subject 1: Physical science and technology (1st year)
2012 - 2013
Course convener: A/Prof. Roger P. Rassool

ACADEMIC AWARDS

POSTGRADUATE RESEARCH SCHOLARSHIP

October 2014 – present

\$27,000 / year

VICE CHANCELLOR HIGHER DEGREE RESEARCHER TRAVEL GRANT

March 2018

This award partially funded travel expenses to an XRD beamtime at the APS (HPCAT).

\$1,500

CARNEGIE INSTITUTION OF WASHINGTON, VISITING INVESTIGATOR AT GEOPHYSICAL LABORATORY

August 2016 – February 2017

This award partially funded a 6 month visit to geophysical laboratory (CIW) to work on high pressure laser heating experiments under the supervision of Dr. Reinhard Boehler. It also covered travel expenses to an XRD beamtime at the APS (HPCAT) and a neutron diffraction beamtime at ORNL (SNAP).

\$12,500

AUSTRALIAN NANOTECHNOLOGY NETWORK OVERSEAS TRAVEL SCHOLARSHIP

October 2015 – December 2015

This award partially funded a 6 week visit to geophysical laboratory (CIW) to work on high pressure laser heating experiments under the supervision of Dr. Reinhard Boehler, and travel expenses to an XRD beamtime at the APS (HPCAT).

\$4,000

PROFESSIONAL MEMBERSHIPS

THE AUSTRALIAN NANOTECHNOLOGY NETWORK

October 2014 – present

THE AUSTRALIAN INSTITUTE OF PHYSICS

October 2014 – present

TECHNICAL SKILLS

HIGH PRESSURE TECHNIQUES

I have organized and held several small training workshops at the Australian

National University which have involved training graduate students and postdoctoral colleagues the basics of diamond anvil cells. This includes practical experience with diamond anvil cell alignment, sample loading, and sample recovery post decompression. These workshops also included introductions to different types of pressure media materials from gases to solids, and pressure calibration methods using Raman spectroscopy (such as ruby fluorescence and diamond anvil line shifts).

LASER HEATING AT HIGH PRESSURE IN A DIAMOND ANVIL CELL

During my PhD study I spent a total of 8 months working under the supervision and guidance of Dr Reinhard Boehler at the Geophysical Laboratory (CIW) in the USA. During this time I was given the freedom to pursue my own research goals which involved using high pressure pulsed laser heating of glassy carbon in a piston DAC to explore certain phase boundaries in the carbon PT-diagram. Dr Boehler and I designed a set of experiments to investigate the phase metastability boundary between graphite and diamond, and also the melting line of diamond. This work involved trialing and experimenting with many different pressure mediums (gases and solids) and pressure calibrant materials to attain optimal repeatable and measurable high pressure and high temperature environments. As a result of this I have practical hands-on experience of laser heating in DACs including practical knowledge of pressure and temperature gradients, and the intricate details of *in situ* temperature measurements on short time scales.

HIGH PRESSURE X-RAY DIFFRACTION BEAMTIMES

During my PhD study I have been a key participant in a total of five high pressure beamtimes at the HPCAT beamline (16-ID-B) at the Advanced Photon Source (USA). I was heavily involved in drafting the accepted proposals for these beamtimes and was responsible for the design, planning, and implementation of many DAC experiments. These experiments have included symmetric, panoramic, and Boehler-plate DACs, as well as a prototype shear DAC. I have often utilised the offline Raman spectroscopy and annealing facilities available there, as well as the online membrane pressure controls and resistive heating units.

X-RAY MICRO-DIFFRACTION BEAMTIMES

In November 2015 I attended an X-ray micro diffraction beamtime at the sector 34-ID-E beamline at the Advanced Photon Source (USA). This beamtime involved collecting diffraction spectra from carbon and silicon samples that had been recovered following DAC compression, and also from the near surfaces of silicon wafers which were covered in nanoindentation arrays in search of phase transformations.

HIGH PRESSURE NEUTRON DIFFRACTION BEAMTIMES

I have been involved in two high pressure neutron diffraction beamtimes at the SNAP beamline at the Spallation Neutron Source (ORNL) for which I wrote

the user proposals. The first beamtime focused on measuring total scattering data from recovered carbon samples that had been compressed in a Paris-Edinburgh press. The second beamtime involved compressing a glassy carbon sample to 44 GPa in a prototype neutron DAC and measuring *in situ* scans.

NEUTRON DIFFRACTION BEAMTIMES

In November 2015 I was involved in a neutron diffraction beamtime at the NOMAD beamline at the Spallation Neutron Source (ORNL). This beamtime involved taking measurements of amorphous germanium samples that had been synthesised via different methods to look for subtle medium range order structural variations.

RAMAN SPECTROSCOPY

I am registered as an expert user of the Renishaw micro-Raman spectrometer based in the Research School of Physics and Engineering at the Australian National University. This certifies me with the responsibility of training new users, assisting with complicated measurements (such as mapping), sample preparation, and data analysis. Additionally, I also perform routine maintenance tasks on this equipment, such as alignment and calibrations.

RESEARCH COLLABORATORS

OAK RIDGE NATIONAL LABORATORY

Dr Bianca Haberl – Bianca is an advisor on my PhD supervisory panel, and is heavily involved with XRD and neutron beamtimes and several joint publications.

GEOPHYSICAL LABORATORY

Dr Reinhard Boehler – Reini was my official supervisor during my time spent at the Geophysical Laboratory (CIW) working on laser heating in DACs. He is also involved with all XRD and neutron beamtimes and several joint publications.

RMIT UNIVERSITY

Professor Dougal McCulloch – Dougal is an advisor my PhD supervisory panel, and is also the head of the electron microscopy facility (the RMMF) at RMIT university where I am currently employed.

THE UNIVERSITY OF SYDNEY

Professor David McKenzie – David was an unofficial supervisor based in Sydney. He is a large contributor to all of my associated papers, both published and in preparation.

CURTIN UNIVERSITY

Associate Professor Nigel Marks – Nigel's team at Curtin University are the contributors of high pressure carbon simulations. We are joint authors on one published paper, and on one more that is in the final stages of preparation.

RESEARCH
SUPERVISION AND
TEACHING

SUPERVISION OF AN UNDERGRADUATE STUDENT

I was responsible for the day to day supervision training of an undergraduate summer student, Ms Sacha Mann, who joined our research group from November 2017 to February 2018. This involved training her to use specific equipment such as diamond anvil cells, a Raman spectrometer, a nanoindenter, and with specific sample preparation methods such as polishing with a polishing wheel and fine (<1 μm) Al_2O_3 paste. This responsibility also involved assisting with thesis preparation and submission, and a final talk. The project was quite successful, Sacha received a high distinction as a total combined mark.

LABORATORY DEMONSTRATING

I have several years of experience as a laboratory demonstrator for undergraduate students. This work involves guiding the students' development of technical skills and laboratory practices, as well as detailed record keeping and experimental report writing. Additionally, I am entrusted with training new laboratory demonstrators, assessing conduct and written student reports, providing feedback to course conveners, and updating the laboratory instruction manuals.

CONFERENCE
PRESENTATIONS

ORAL PRESENTATIONS

RACI congress (July 2017) in Melbourne, Australia. Talk title "Graphitization of glassy carbon by room temperature compression"

MRS (November 2016) in Boston, USA. Talk title "Nanocrystalline hexagonal diamond formed from glassy carbon"

ACMM-24 (February 2016) in Melbourne, Australia. Talk title "Nanocrystalline hexagonal diamond"

POSTER PRESENTATIONS

ICONN (February 2018) Wollongong, Australia. Poster title "Compressed glassy carbon"

AIP (December 2017) in Sydney, Australia. Poster title "Structure-property relations of glassy carbon"

ICONN (February 2016) in Canberra, Australia. Poster title "Permanent microstructural changes to glassy carbon after compression to 112 GPa in a diamond anvil cell"

COMMAD (December 2012) in Melbourne, Australia. Poster title "Few layered graphene growth by carbon implantation into a polycrystalline nickel substrate"

PUBLICATIONS

1. *IN SITU* ANALYSIS OF THE STRUCTURAL TRANSFORMATION OF GLASSY CARBON UNDER COMPRESSION AT ROOM TEMPERATURE

Thomas B. Shiell, Carla de Tomas, Dougal G. McCulloch, David R. McKenzie, Abhisek Basu, Reinhard Boehler, Irene Suarez-Martinez, Nigel A. Marks, Bianca Haberl, and Jodie E. Bradby

Accepted, awaiting publication - Physical Review B.

2. THE SHEAR-DRIVEN TRANSFORMATION MECHANISM FROM GLASSY CARBON TO HEXAGONAL DIAMOND

Sherman Wong, **Thomas B. Shiell**, Brenton A. Cook, Jodie E. Bradby, David R. McKenzie, and Dougal G. McCulloch

Carbon 142, 475-481 (2018)

3. GRAPHITIZATION OF GLASSY CARBON AFTER COMPRESSION AT ROOM TEMPERATURE

Thomas B. Shiell, Dougal G. McCulloch, David R. McKenzie, Matthew R. Field, Bianca Haberl, Reinhard Boehler, Brenton A. Cook, Carla de Tomas, Irene Suarez-Martinez, Nigel A. Marks, and Jodie E. Bradby

Physical review letters 120 (21), 215701 (2018)

2 citations

4. UNDERSTANDING THE UNUSUAL RESPONSE TO HIGH PRESSURE IN $\text{KBe}_2\text{BO}_3\text{F}_2$

DH Yu, M Avdeev, DH Sun, Larissa Q. Huston, **Thomas B. Shiell**, QB Sun, T Lu, Q Gu, H Liu, Jodie E. Bradby, N Yie, Y Liu, JY Wang, GJ McIntyre

Scientific Reports 7 (1), 4027 (2017)

5. NANOCRYSTALLINE HEXAGONAL DIAMOND FORMED FROM GLASSY CARBON

Thomas B. Shiell, Dougal G. McCulloch, Jodie E. Bradby, Bianca Haberl, Reinhard Boehler, and David R. McKenzie

Scientific Reports 6, 37232 (2016)

20 citations

6. THE DIFFERENCES IN COMPOSITION, STRUCTURE AND PROPERTIES BETWEEN TYPE I AND TYPE II GLASSY CARBONS

Thomas B. Shiell, Wenjie Yang, Chris Tanner, Sherman Wong, Bianca Haberl, Reinhard Boehler, Matthew Tucker, Robert Elliman, David R. McKenzie, Dougal G. McCulloch, and Jodie E. Bradby

Currently under review at Carbon (Elsevier).

PUBLICATIONS IN PREPARATION

1. "SHEAR STRAIN DRIVEN FORMATION OF SYNTHETIC DIAMOND AT ROOM TEMPERATURE"

Sherman Wong, **Thomas B. Shiell**, Brenton A. Cook, Carla de Tomas, Irene Suarez-Martinez, Nigel A. Marks, Jodie E. Bradby, David R. McKenzie, and Dougal G. McCulloch

Intended journal – Nature Materials

2. "NEUTRONS DISCRIMINATE BETWEEN MODELS FOR THE NANOARCHITECTURE OF GRAPHENE SHEETS IN GLASSY CARBON"

Thomas B. Shiell, Jodie E. Bradby, Dougal G. McCulloch, Bianca Haberl, and David R. McKenzie

Intended journal – Nature Communications

3. "MELTING OF DIAMOND AT HIGH PRESSURE"

Liuxiang Yang, **Thomas B. Shiell**, Amol Karandikar, Brenton A. Cook, Matthew Field, Sherman Wong, Bianca Haberl, Jodie E. Bradby, Dougal G. McCulloch, and Reinhard Boehler

Intended journal – Science

4. "HIGH PRESSURE PULSE LASER MELTING OF CARBON"

Brenton A. Cook, **Thomas B. Shiell**, Sherman Wong, Jodie E. Bradby, David R. McKenzie, Dougal G. McCulloch, and Reinhard Boehler

Intended journal – High Pressure Research

BIBLIOMETRICS

1. Google scholar profile: Thomas B. Shiell, The Australian National University
2. ORCID profile: 0000-0002-3541-6562
3. LinkedIn profile: Thomas B. Shiell, The Australian National University

REFERENCES

PROF. JODIE E. BRADBY (CHAIR OF PHD SUPERVISORY PANEL)

Professor, The Australian National University

Email: Jodie.bradby@anu.edu.au

DR. REINHARD BOEHLER (FORMER SUPERVISOR AT GEOPHYSICAL LABORATORY)

Senior Neutron High Pressure Research Scientist, Oak Ridge National Laboratory

Email: boehlerr@ornl.gov

PROF. DOUGAL G. MCCULLOCH (PHD ADVISOR AND CURRENT EMPLOYER)

Professor, RMIT University

Email: dougal.mcculloch@rmit.edu.au

DR. BIANCA HABERL (PHD ADVISOR)

High Pressure Science Coordinator, Oak Ridge National Laboratory

Email: haberlb@ornl.gov