

# Curriculum Vitae: Andrew Anthony Bettiol



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## Education and qualifications

1994–1999 Ph.D., School of Physics, University of Melbourne, Australia

1990–1993 B.Sc. (1<sup>st</sup> Class Honours), School of Physics, University of Melbourne, Australia

## Current appointments

- Associate Professor, Department of Physics, Faculty of Science, National University of Singapore
- Associate of the Engineering Science Programme, Faculty of Engineering, National University of Singapore
- Principle Investigator, Centre for Ion Beam Applications (CIBA), NUS
- Principle Investigator, Singapore Institute for Neurotechnology (SINAPSE), NUS
- Adjunct Researcher, Solar Energy Research Institute, Singapore (SERIS), NUS

## Previous appointments

2007 – 2013 Assistant Professor, Department of Physics, National University of Singapore

2006 – 2007 Senior Research Fellow, Department of Physics, National University of Singapore

2001 – 2006 Research Fellow, Department of Physics, National University of Singapore

1999 – 2001 NSTB Post Doctoral Fellow, Department of Physics, National University of Singapore

## Awards and prizes

1992 E.M. & J.F. Ward prize in experimental physics (Uni. of Melb.)

1993–96 Australian Post-graduate Research Award (APRA) (Uni. of Melb.)

1996 School of Graduate studies traveling scholarship (Uni. of Melb.)

2001 National Institute of Radiological Science (NIRS) Japan, Special Coordination Fellowship for promotion of science and technology.

2008 First Prize (Academic category) in the National Instruments 2008 ASEAN Virtual Instrumentation Applications Contest.

2008 Faculty of Engineering, National University of Singapore, Innovative Teaching Award 2007/08 (As part of the Engineering Science Programme Design Project Team)

## Membership of professional societies

American Physical Society (APS), Materials Research Society (MRS), Microscopy Society, Singapore (Vice president from 2003–2006, 2008–2010), SPIE - International Society for Optical Engineering, Optical Society of America (OSA), Materials Research Society, Singapore (MRS-S), Institute of Physics, Singapore.

## Research interests

### Optics and Photonics

- Ion beam modification of materials for applications in micro/nanophotonics.
- Terahertz spectroscopy and optics - Application in metamaterials.
- Active plasmonics, loss mitigation in micro-optical systems, enhancement of light emission using plasmonics.
- Mid-IR optics, passive and active devices for biosensing.
- Integrated optics for microfluidic applications.

### Nuclear Microscopy and Radiobiology

- Proton induced fluorescence microscopy in biological systems - Super-resolution imaging.
- Radiation effects in single live cells - Applications in cancer treatment using particle therapy.
- Development of diamond based radiation hard particle detectors, delta-E detectors using thin membranes, radiation dosimetry.

## Research highlighted in magazines, journals and websites

- Editors Choice, **Science** Vol. 301, 5 Sept. 2003 page 1292, "Accelerating Lithography."
- News Breaks, **Laser Focus World**, March 2004 page 9, "Proton Beam Writes erbium-doped waveguide amplifiers."
- Research News, **Materials Today**, July/August 2004 page 21, "Writing Structures in Silicon."
- Research/Researchers, **MRS Bulletin**, Vol. 31 MAY 2006 pages 367-368, "3D Nanostructures in Hydrogen Silsesquioxane Achieved by Proton Beam Writing."
- News Breaks, **Laser Focus World**, December 2010 page 9, "Microfluidic chip has integrated optics for particle sorting."
- News and Views, **Nature Photonics**, Vol. 5, Feb. 2011 page 74, "Optical Microfabrication: Proton-beam Writing."
- **Science Daily**, 4<sup>th</sup> Oct. 2011, "Helium Raises Resolution of Whole Cell Imaging."
- **Science Daily**, 8<sup>th</sup> Jul. 2014, "Plasmonics: Minimizing loss by thinning, smoothing."

## Teaching and curriculum development

- Joined the Engineering Science Programme (ESP) in 2007. Developed several new modules including two design projects (Laboratory based) and three lecture based modules.
- Developed two new ESP design projects with colleagues in ESP. The first was a project on designing and building a WiFi antenna. The students then test the antenna by finding hidden WiFi transceivers using triangulation. Students learn various electromagnetism principles like impedance matching, and learn to fully characterize their antennas. The second design project involves designing a microfluidic mixing and sorting device. They characterize their device using microscopy and fluorescence imaging techniques. They also develop their own software tools for characterizing the devices.
- Set up a new laboratory in faculty of science for engineering science students year 3 design projects. This laboratory occupies some of the space in my research laboratory. It includes a state of the art biological inverted microscope for bright field and fluorescence imaging. Various video and fluorescence cameras and a pressure driven microfluidic pumping system.
- Twice (2011/12 and 2013/14) awarded the teaching commendation award by ESP for the top three lecturers based on student feed back scores.
- Part of the ESP design project team to be awarded the Faculty of Engineering innovative teaching award in 2007/08 for "innovations for integrative learning".

## Publication statistics

Source: Web of Science August 2014

- **Researcher ID:** [D-5699-2011](#)
- **H-Index :** 25
- **Number of papers :** Refereed Journals=146, Conference Proceedings=48.
- **Total number of citations :** over 2400

### Book chapters

- J. A. van Kan and A. A. Bettiol (2009). Proton Beam Writing: A new 3D nanolithographic technique. In: [Ion Beams for Nanoscience and Technology](#). Ed. by R. Hellborg, H. J. Whitlow, and Y. Zhang. Springer, pp.297–310. isbn: 978-3-642-00622-7.
- A. A. Bettiol (2009). Proton Beam Writing of Optical Structures. In: [Ion Beams for Nanoscience and Technology](#) Ed. by R. Hellborg, H. J. Whitlow, and Y. Zhang. Springer, pp.311–313. isbn: 978-3-642-00622-7.

### Edited volumes

- Guest Editor, Proceedings of the 2nd International Workshop on Proton Beam Writing, Singapore, July 2006. Published in [Nuclear Instruments and Methods B Volume 260 Number 1 \(2007\)](#).
- Guest Editor, Proceedings of Symposium BB: Nanoscale Imaging, Fabrication and Materials Modification Using Ion Beams. International Conference on Materials for Advanced Technologies (ICMAT), July 2011. Published in [Microelectronic Engineering Volume 102 \(2013\)](#).

## Top five most cited publications

No.	Reference	Citations
1	J. A. van Kan, A. A. Bettiol, and F. Watt, Three-dimensional nanolithography using proton beam writing, <a href="#">Applied Physics Letters 83(8):1629-1631, AUG 2003</a> .	118
2	F. Watt, J. A. van Kan, I. Rajta, A. A. Bettiol, T. F. Choo, M. B. H. Breese, and T. Osipowicz, The National University of Singapore high energy ion nano-probe facility: Performance tests, <a href="#">Nuclear Instruments and Methods B 210:14-20, SEP 2003</a> .	113
5	Sher-Yi Chiam, Ranjan Singh, Carsten Rockstuhl, Falk Lederer, Weili Zhang, and Andrew A. Bettiol, Analogue of electromagnetically induced transparency in a terahertz metamaterial, <a href="#">Physical Review B, 80(15):153103, OCT 2009</a> .	112
4	Frank Watt, Mark B. H. Breese, Andrew A. Bettiol, and Jeroen A. van Kan, Proton beam writing, <a href="#">Materials Today, 10(6):20-29, JUN 2007</a> .	93
5	K. Ansari, J. A. van Kan, A. A. Bettiol, and F. Watt, Fabrication of high aspect ratio 100 nm metallic stamps for nanoimprint lithography using proton beam writing, <a href="#">Applied Physics Letters 85(3):476-478, JUL 2004</a> .	83

## Conference and workshop organization

Date	Conference/Workshop Title
18–22 Sep. 2004	Local organizing committee, 1st International workshop on P-beam writing, Singapore.
10–14 Jul. 2006	Local organizing committee, 10 <sup>th</sup> International Conference on Nuclear Microprobe Technology and Applications (ICNMTA2006), Singapore.
26–30 Jul. 2010	Programme committee, 12 <sup>th</sup> International Conference on Nuclear Microprobe Technology and Applications (ICNMTA2010), Leipzig Germany.
26 Jun.–1 Jul. 2011	Symposium chair, Symposium BB–Nanoscale Imaging, Fabrication and Materials Modification Using Ion Beams, International Conference on Materials for Advanced Technologies (ICMAT2011), Singapore.

## Invited talks at international conferences

Date	Presentation Title/Conference
2–4 Dec. 2002	Proton beam micromachining: A new 3D sub-100 nm direct-write technique, Symposium H - Three Dimensional Nano-engineered Assemblies, MRS Fall meeting, Boston, USA.
13–17 Sep. 2004	Proton beam writing : Applications in microphotonics, 9 <sup>th</sup> International Conference on Nuclear Microprobe technology and applications (ICNMTA2004), Dubrovnik, Croatia.
10–14 Jul. 2006	Embedded photonic structures fabricated in photosensitive glass using proton beam writing, 10 <sup>th</sup> International conference on Nuclear Microprobe technology and applications (ICNMTA), Singapore.
9–13 Apr. 2007	Direct write nanolithography with focused mega electron volt protons, Symposium GG Ion Beam Based Nanofabrication, MRS Spring meeting, San Francisco, USA.
3–7 Sep. 2007	Direct write nanolithography with focused mega electron volt protons, 9 <sup>th</sup> European conference on accelerators in applied research and technology (ECAART), Florence, Italy.
20–25 Jul. 2008	Proton beam writing of microstructures for microphotonic applications, 11 <sup>th</sup> International conference on Nuclear Microprobe technology and applications (ICNMTA2008), Debrecen, Hungary.
28 Jul. – 1 Aug. 2008	Proton Beam Writing, IUMRS - International Conference on Electronic Materials (ICEM08), Sydney, Australia.
26–30 Jul. 2010	<b>Invited plenary talk:</b> Proton Beam Writing, 12 <sup>th</sup> International Conference on Nuclear Microprobe Technology and Applications (ICNMTA2010), Leipzig, Germany.
4–7 Aug. 2010	Nanolithography with Focused MeV Ion Beams: The Current State of the Art and Future Directions, Huntsville Ion Beam Institute Workshop, Huntsville, Alabama, USA.
2–7 Sep. 2012	Nanolithography and materials modification using focused MeV ions: Recent progress and applications, The 18 <sup>th</sup> International Conference on Ion Beam Modification of Materials (IBMM2012), Qingdao, China
6-11 Jul. 2014	Ion beam Induced Fluorescence Imaging in Biological Systems, 14 <sup>th</sup> International Conference on Nuclear Microprobe technology and applications (ICNMTA2014), Padua, Italy.

## Other invited seminars

Date	Presentation Title/Location
19 Apr. 2007	Seminar at IBM research Labs, Almaden USA, Direct Write Nanolithography with MeV protons, Host: Stuart Parkin
Aug. 2007	Seminar at the Advanced Technology Institute, University of Surrey, UK, Proton Beam Writing, Host: Graham Reed

## Research grants

Date	Title	Role	Authority	Amount (SGD)
1/02/08-31/1/11	Development of Multiphoton lithography for the fabrication of sub 100 nm photonic structures. (R-144-000-231-133)	PI	Start-up	\$288,778.00
1/03/08-28/02/11	The development of fluorescence and structural imaging of cells and tissue at sub 50nm resolutions. (R-144-000-227-305)	Co-PI	SBIC (A*Star)	\$994,000.00
1/04/09-31/03/11	Pilot study of ion implanted waveguides in lithium niobate. (R-263-000-529-646)	Co-PI	Cross-faculty grant	\$49,185.50
1/08/09-31/01/12	Integrated optical cells/particles sorter. (R-144-000-258-112)	PI	AcRF Tier 1	\$152,000.00
1/04/11-31/03/13	Three dimensional metamaterials fabricated using two photon lithography. (R-144-000-291-112)	PI	AcRF Tier 1	\$128,415.00
1/06/12-31/05/15	The development of nano-probes and imaging techniques for subcellular high resolution imaging. (R-148-000-164-112)	Co-PI	AcRF Tier 1	\$142,000.00
1/01/13-31/12/15	Whole cell imaging at nanometre resolution using fast nuclear particles: Development and applications. (R-148-000-306-112)	PI	AcRF Tier 2	\$457,994.00
1/08/14-31/07/17	Fundamental Investigations into Proton Beam Therapy at the sub-cellular level	PI	NCCS donation	\$1,000,000.00

## Patents and invention disclosures

Date	Title	Country	File Number	Status
16/03/2004	Multi-Spot Optical Tweezers	USA	60/553,237	Abandoned
05/05/2004	Controlled Particle Size and Wavelength Emission from Porous Semiconductors Using Focused Ion Beams	USA	60/568,448	Converted
05/05/2005	Controlled Particle Size and Wavelength Emission from Porous Semiconductors Using Focused Ion Beams	PCT	PCT/SG2005/000140	Abandoned
22/02/2008	Bioimaging at Nanometer Spatial Resolutions Using Ion Induced Fluorescence	USA	61/066,805	Abandoned
17/04/2009	Ion Induced Fluorescence in Bioimaging	USA	61/170,129	Abandoned
26/04/2013	High Speed Surface Plasmon Coupled Light Emitting Diode	Singapore	201303250-3	Converted
28/04/2014	High Speed Surface Plasmon Coupled Light Emitting Diode	PCT	PCT/SG2014/000190	Filed

## Graduate students supervised

Supervised a total of 18 Ph.D. students and 1 M.Sc. student. (11 have graduated)

Student Name	Project Title	Supervisc	Degree	Graduated
Sum Tze Chien	Waveguide fabrication using proton beam writing	Co.	PhD	2004
Chammika Udalagama	Optimization and computer control of the sub 100 nm proton beam writing facility at CIBA	Co.	PhD	2005
Hoi Siew Kit	Development of Integrated microfluidic systems with added optical functionality	Co	PhD	2010
Ow Yueh Sheng	Micromachining of Silicon via ion Irradiation with Porous Silicon Formation	Co.	PhD	2011
Sureerat Homhuan	Single cell electroporation using proton beam fabricated biochips	Co.	PhD	2011
Chan Sook Fun	Proton Beam Fabricated Lab-on-a-chip for Single Molecule Detection	Co.	MSc	2011
Chiam Sheryi	Electromagnetic resonance in 3-dimensional metallic structures	Main.	PhD	2012
Yan Yuanjun	Fabrication of 3D metamaterials using two-photon polymerization and selective silver electroless plating	Sole	PhD	2012
Chen Xiao	The construction and implementation of a dedicated beam line facility for ion beam bioimaging	Main.	PhD	2012
Vanga Sudheer Kumar	Ion Beam Writing and Modification for integrated optics	Sole	PhD	2013
Wu Jianfeng	THz Meta-Foils: A platform for practical applications of metamaterials	Co.	PhD	2014
Yang Chengyuan	Active Plasmonic Devices	Main	PhD	Current
Prashant Shuvan	Fabrication of photonic devices using a femtosecond laser	Sole	PhD	Current
Mi Zhaohong	Proton Induced Fluorescence in biomedical specimens	Main	PhD	Current
Kwan Bum Choi	Solar Cell characterization using PL and Terahertz-Main	Main	PhD	Current
Tao Ye	Single Cell hit - Radiobiology	Co.	PhD	Current
Shi Yi	Metasurfaces and Plasmonics	Main	PhD	Current
Tan Hong Qi	Single Cell hit facility - Imaging	Co	PhD	Current
Jin Huining	Diamond Photonics	Main	PhD	Current

## Undergraduate and other students supervised or mentored

- 4 Physics honours projects
- 16 Engineering Science Final Year Projects from 2009-2014,
- 2 UROPS projects
- 5 Vacation internship students as part of the SIPIS programme
- 17 NUS high school students as part of the SCIENTA programme. These students went of to win 2 gold and 2 bronze medals at the Singapore Science and Engineering Fair (SSEF).

## Modules taught

Year	Module code and title	Description
2006	PC3235–Solid State Physics I	Third year undergraduate solid state physics module.
2007–2008	PC1433–Mechanics and Waves	First year mechanics and waves course for engineering science students.
2008, 2010–2014	ESP1104–Introduction to Electronic Systems	First year course on analog and digital electronics.
2008–2010	ESP2110–Design Project	Second year design project on Electromagnetics - "Design your own WiFi antenna"
2008–2014	ESP3901–Major Design Project	Third year design project - "Microfluidics and biochips"
2009–2014	ESP4302–Nanophotonics	Final year undergraduate course on Photonic crystals, plasmonics, metamaterials.
2007–2013	PC5198–Graduate Seminars	Graduate student course in presentation skills.