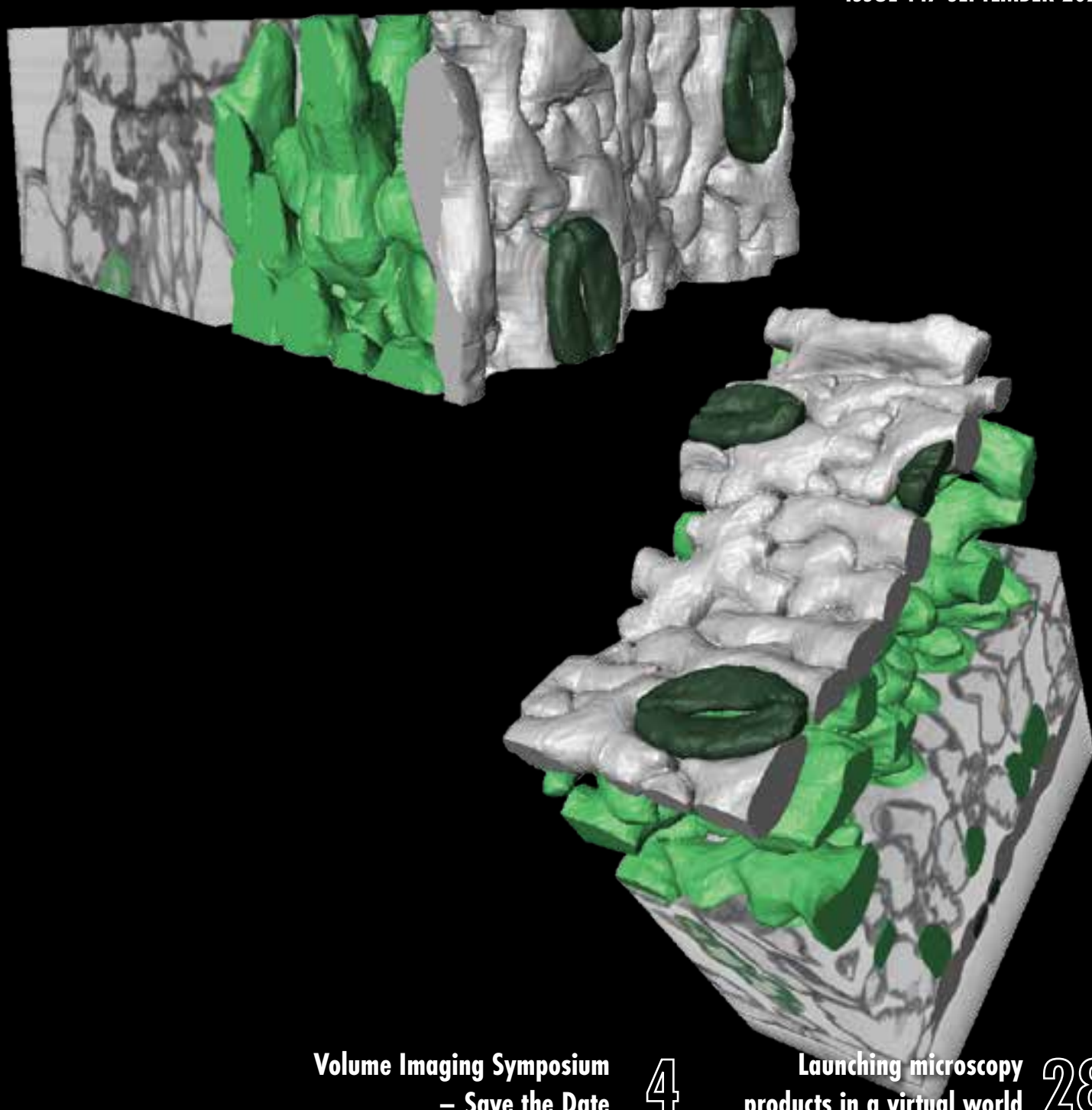


AUSTRALIAN MICROSCOPY & MICROANALYSIS NEWSLETTER

ISSUE 147 SEPTEMBER 2020



Volume Imaging Symposium
– Save the Date

4

Launching microscopy
products in a virtual world

28

SU3900 VP-SEM *with an Extra-Large Chamber*

Hitachi's SU3900 Variable-Pressure SEM features an extra-large chamber to accommodate a multitude of analytical applications: EDS, EBSD, micro XRF, in situ, heating, cooling, tensile testing, and more. Equipped with 20 ports and a robust stage, the SU3900 can handle it all! Whether your sample is large, small, heavy, magnetic, or non-conductive, the SU3900 is the instrument for your lab.

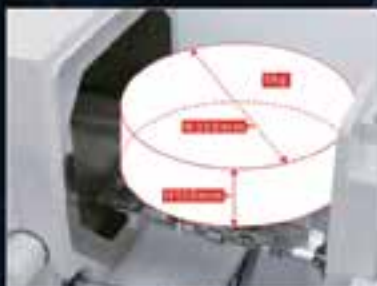
- **Extra-Large Chamber & Heavy-Sample Stage**
Superior X/Y range of motion for up to 5 kg sample weight
- **Ultra-Wide NaviCam FOV**
Covering full observation sample area (200 mm ϕ)
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Auto optimization for improved filament performance and lifetime
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Seamless SEM and EDS operation from a single GUI



Size without compromise



Sample: Pure Titanium Accelerating Voltage: 3 kV
Magnification: 800x



Extra-large chamber for max. 300 mm ϕ , 130 mm tall, and 5 kg sample

Science for a better tomorrow

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The newsletter is normally published in the first week of March, June, September and December. The deadline for submission of all material is the middle of the preceding month. The views expressed in this newsletter are those of the authors and not necessarily those of the AMMS Inc for which this newsletter is the official publication. No responsibility can or will be taken for the accuracy of articles published in this newsletter but all reasonable attempts have been made to ensure the information is factual. Any technical articles are reviewed by our editor and specialist reviewers.

Designed by Studio Mood

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Cover: Composite 3D renderings and serial block face scanning electron microscopy (SBF-SEM) image stacks of plant cells. See Dr Richard Harwood's story (page 34) in this issue.

ISSN 1446-6090

EDITORIAL

WELCOME TO ISSUE 147.
MANY THANKS to this edition's contributors! I'm not sure about everyone else, but universities feel like that duck analogy, where everything seems calm and placid on the surface, but there is frantic paddling going on under the water. With the evaporation of a large cohort of international students, the campus appears quiet but there is still a bucket load of research activity happening behind the scenes.

We are now starting to see our customary gatherings, like M&M, come to pass in a true test of the online format. In this regard, I very much enjoyed Pat Trimby's article in this issue, which appraised the COVID enforced digital format of M&M from an instrument vendor's perspective. By and large it sounds like the event was a great success, but the face-to-face spontaneity of such meetings is almost impossible to replicate. Thank you Pat for putting that article together. In this vein, special interest group (SIG) symposia will be held online in the near future, so watch this space for announcements. Looking further ahead in a post-COVID Australia, (we hope) the Australian Conference on Microscopy and Microanalysis (ACMM), will be held in Perth in 2022 (see

announcement this issue). I have the feeling that ACMM27 may be the first opportunity our community will have had to gather physically for a considerable time. I hope we can let our hair down at this meeting and do some celebrating.

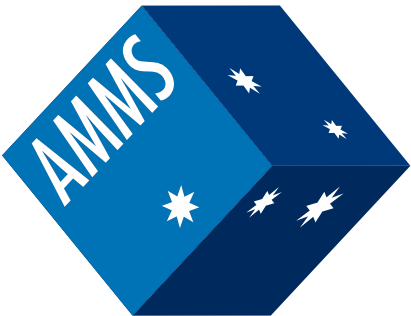
As promised in my last editorial, Prof. Philip Nakashima has provided an excellent obituary for the late Prof. Andrew Johnson. Thank you Phil for providing such a great summary of Andy's exploits. The extensive list of formidable people Andy worked with is quite something and his flair for teaching shines through, as does his passion for inspiring the love of science in others. The pandemic has made it difficult for some of us to properly acknowledge the passing of loved ones. I know a number of students and staff who have been unable to attend funerals and my sympathies go out to those finding themselves in this position. It is therefore excellent that we can mark Andy's passing this way.

OK, onto my fishy thoughts for the issue. One positive aspect of a university sector wide downturn is (in our case) additional enforced leave (No disrespect intended to those who have had more undesirable employment outcomes). I have just chewed up



Dr Jeremy Shaw
Newsletter Editor
AMMS

five of these extra days travelling to the north side of the Murchison River in Kalbarri, Western Australia (obviously). Eight of us camped, fished, ate, drank and got devoured by ticks and sandflies, loving every minute. Fish were caught, but I'll just show a picture of the gorge at Z-Bend in the Kalbarri National Park. Here we wallowed in the waterholes in the heat of the day. Magic. OK maybe one fish pic. My brother-in-law not me.



**Australian Microscopy
& Microanalysis Society**

PRESIDENT'S REPORT

THINGS GOT BETTER THEN THEY GOT WORSE

In my last column I was talking about the pandemic like a thing of the past. It turns out I probably shouldn't have. After another few weeks of lock down and still a few to go things have definitely changed for the foreseeable future, at least for the Victorians.

I have been living in Victoria for 15 years after spending my first 5 years in Australia in Adelaide. I still consider myself a French South Australian but reality has now crept up on me and I now find myself with all the other Victorians, stuck at home. At least we have enough COVID-19 projects that we are able to attend the laboratory, even some from SA.

As predicted by most, jobs have been lost, even in our small community, and more will be lost in the near future. Again, this is a very good time to show some support to those who have lost their positions. At least the next round of grant results is now very near and with it a chance of new positions appearing.

The effects of this pandemic are only starting to be felt around the world and obviously in Australia. Closer to home, the effect will be

felt by AMMS next year with all our special interest groups considering to hold their respective symposia online. We are currently trying to work out a solution that would benefit all.

As of next year, we will have the current three groups, in order of creation, AMAS, LMA and CryOz, and two new ones in their trial year, the Volume Imaging and the Focus Ion Beam groups. The latest two initiatives are lead on one side by Jeremy Shaw from UWA and on the other by Annalena Wolff from QUT, respectively.

Ever closer to home, at least from my perspective, COVID-19 has had some impact on the delivery of our new facility that was supposed to be ready last month. With it, the late delivery of our new flagship Krios G4. But this is only a small delay and should still see us operational late this year. In the still good news chapter, I am hearing the new cryo-EM facility at UQ has been doing very well and is set to have an official opening sometime in 2021.

All the dates seems quite fluid these days and we will hopefully firm them up in the next few months.

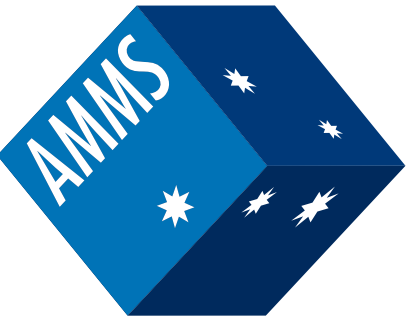
Until next time ...



Assoc. Prof. Eric Hanssen
President
AMMS

“

This is a very good time to show some support to those who have lost their positions. At least the next round of grant results is now very near and with it a chance of new positions appearing.



**Australian Microscopy
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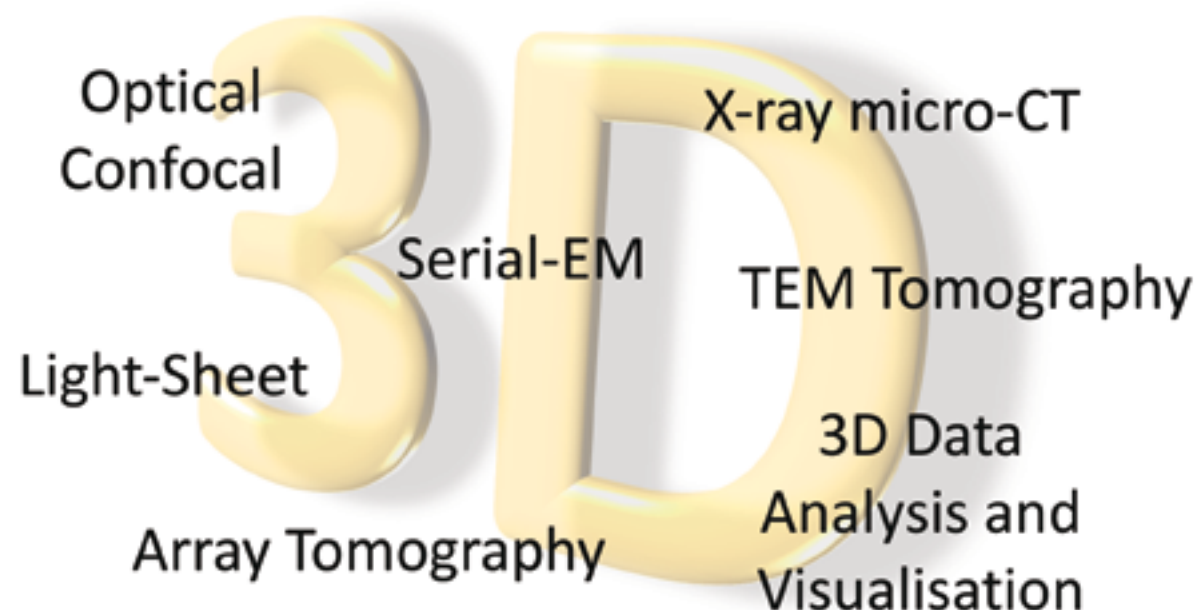
SAVE THE DATE VOLUME IMAGING SYMPOSIUM

The acquisition of 3D volumetric data now spans a diverse range of imaging techniques with applications across all fields of science. The Australian Microscopy and Microanalysis Society (AMMS) will host an online four half-day symposium on volume imaging during the week beginning the 15th of February 2021.

Exact program dates, times and session details to be announced.

Contact Dr Jeremy Shaw for more information:

jeremy.shaw@uwa.edu.au



OBITUARY

Vale Professor Andrew William Syme Johnson (1936 – 2020)

TO HAVE LEARNED FROM, WORKED WITH and enjoyed a wonderful friendship with Prof. Andrew Johnson is to have known one of the greats of academia and scientific research. He infused so many with the enthusiasm, curiosity and love of science and electron microscopy that make being a microscopist such a wondrous thing.

Andy, as we affectionately knew him, was a key figure in a golden age of electron microscopy, diffraction (especially convergent-beam electron diffraction) and dynamical scattering theory, working at CSIRO for nearly 20 years in the '60s, '70s and early '80s, before returning to UWA to direct the Centre for Microscopy and Microanalysis (CMM) and later retire (officially) from the Centre for Microscopy, Characterisation and Analysis (CMCA) as it is known today.

It all started when, as a struggling PhD student (quoting him) at UWA, he happened to visit CSIRO at Fisherman's Bend in Melbourne in 1962. John Sanders introduced Andy to Alex Moodie who had only 5 years earlier published the slice theory with John Cowley. It was an incredible day in which Andy asked Alex and Lloyd Rees over afternoon tea if he could perform the experimental work for his PhD project with them. After a rapid consultation, to Andy's delight, the answer was in the affirmative. By mid-1963, with the help of Lloyd Rees, Alex Moodie, David Wadsley and Alan Walsh (a remarkable list of names), Andy had all of his PhD results and returned to Perth to write his thesis.

In 1965, Andy came back to CSIRO having been appointed as a Research Scientist in Alex Moodie's Electron Diffraction Group in the Division of Chemical Physics. The other members of the



Andy "testing the suspension" of the Philips EM430 300 kV TEM in 1985 (courtesy of CMCA).

group included Ernst Chakanovskis and Peter Goodman. In the closely related group of Electron Microscopy at the time were John Farrant, Walter Dowell and Des McLean and when Andy came to visit Melbourne on many occasions in recent years, he stayed with the McLeans very often. Others in Chemical Physics at the time when Andy joined and with whom he would have many enjoyable

and fruitful interactions included Denis Lynch, Andrew Hurley, Barrie Dawson and Sandy Mathieson, just to name a few. Andy spoke very often and with great fondness about his years at CSIRO.

Some amazing work came out of those years, including Andy's configuration of the analogue computer to run multiple-beam dynamical diffraction calculations in many orders of magnitude less



Andy and Ding in deep conversation at ACMM24 in Melbourne, 2016 (photo courtesy of Ding Peng).

time than it took a digital computer in those days [1]. This was early work in which Andy coupled his enthusiasm for electronics with research and this particular application (revisited later by Andy for the Laue case in N-beam X-ray diffraction [2]) gained him considerable renown. As long as I have known him, Andy always had an electronics project, or ten, on the boil! His most recent feat was to re-configure the heating element in a Philips TEM cold stage to be able to produce very large electric fields across small regions of a specimen with the aim of doing convergent-beam electron diffraction (CBED) experiments in materials with a high dielectric constant under high fields. This work was still in progress at the time of his passing.

One of my personal favourites

of Andy's research was his observations of trigonal symmetry in CBED patterns from faulted graphite [3]. This work made use of the multi-slice computation method of Goodman and Moodie [4], which was based on the slice theory of Cowley and Moodie [5]. The work showed how sensitive CBED is to the location of a single stacking fault along the beam direction and, furthermore, that pattern symmetry depends on the symmetry of the entire crystal and not just that of the unit cell. This research is the pioneer of work that we are doing today with quantitative convergent-beam electron diffraction (QCBED) in nano-structured materials [6].

In the late '60s and early '70s, the comparison of computed n-beam CBED intensities with experimental CBED patterns

gave rise to the field of QCBED. This was begun by the work of Goodman and Lehmpfuhl [7] using multi-slice calculations and experimental CBED patterns for MgO. The accurate measurement of structure factors using CBED is something that Andy pursued with great interest over the years that followed, in collaboration with Gunter Lehmpfuhl and others [8 – 10] in the '70s but then again later in the '90s [11] with Hamish Fraser's group at Ohio State University, well after Andy's move from CSIRO to UWA. QCBED remained a primary interest of Andy's, which I pursued under his supervision with Victor Streltsov and Ted Maslen as an Honours student and then again during my PhD under Andy and Victor at UWA, [12, 13]. I will have more to say about this on a personal note



Carlos Otero-Díaz, Ray Withers, Kaye Negus and Andy at the IUCr Congress and General Assembly in Madrid, 2011 (photo courtesy of Ray Withers).



Andy giving a very interesting and entertaining account of Alex Moodie at IMC19 in Sydney to commemorate Alex's passing in 2018.

later, especially given that this area of research has defined my own career path so completely.

With such a buzz surrounding electron diffraction at CSIRO in the '50s, '60s and '70s and the rapid advances in both theory and experiments being made there and around the world, some of the key figures at CSIRO – Barrie Dawson, Peter Goodman, Andy, Denis Lynch and Alex Moodie – came together to set forth definitions and units to be used as the norms in the field [14]. This, to me, is symbolic of the prominence that Australia enjoyed in electron microscopy and diffraction in that golden age.

As a CBED devotee, I have always admired Andy's very elegant work in space group

determination and in particular, distinguishing between enantiomorphically-related space groups with CBED. Work during the CSIRO years with Peter Goodman [15] and then more recently at UWA [16, 17] are prime examples of how the very strong dynamical scattering of electrons is key to the unambiguous determination of structural chirality from the intensities in CBED patterns. Andy's work on other CBED space group determinations [18 – 21] involved numerous collaborations and some very nice friendships (David Cockayne, Frank Lincoln and Carlos Otero-Díaz spring to mind and there are many others). When I observed Andy's CBED space group determination

work with his Masters student, Daniel Jones, I used to gasp at the beauty of CBED as well as how sensitively it could pick up structural symmetry. I'm sure Daniel would agree with me that thanks to Andy, we were both bitten hard by the CBED bug.

But CBED is not just about space group determinations and measuring structure factors. It can also be a fantastically accurate and precise tool for calibrating electron energies. This is illustrated by the work of John Fitz Gerald with Andy [22] from just around the time when Andy was to move back to Perth to become Director of CMM at UWA.

Andy directed CMM from 1983 to 1995 and it was towards the end of this period that I first met him as a very green third year Physics student who had come to the transmission electron microscopy laboratory. Andy and Arne Olsen had just had their contribution to the International Tables for Crystallography published [23]. I can now appreciate how busy his role must have kept him, though I didn't appreciate things like that at the time. Even so, he never let go of research and always took the time to teach students in his animated, enthusiastic and profoundly clear way. I think that to be a good teacher, you have to be a good entertainer as well, and all of us who knew him know that there was never a dull nanosecond with Andy. He was a remarkable teacher, supervisor, mentor and friend to me for the next 26 years.

Well, that first day on the Siemens Elmiskop 80 was a huge learning curve as Andy practically danced his way over the machine with my lab partner and me in tow. I had never seen an academic so enthusiastic and vivacious and the lesson was delivered at a cracking pace followed by leaving us our complete freedom in that laboratory for the next 3 weeks. He was always there for us if we needed him and always keen to share his immense trove of knowledge, but the freedom that

Andy gave us allowed us to really explore things for ourselves. To me, it opened up a new world, not just because we were looking at things that could otherwise not be seen, but because of the freedom that came with exploring. This spirit of research was Andy right to the core.

A year later and after discovering we were both members of the same yacht club (Royal Freshwater Bay), I started an Honours project in Physics with Andy who supervised me together with Victor Streltsov and Ted Maslen. I had graduated from the old Elmiskop 80 to the Philips EM430 which had a brand new GatanTM Image Filter (GIF) attached to it (one of the first in Australia) and thus began a project on measuring structure factors in rare-earth oxides by QCBED using zero-loss energy-filtered CBED patterns. After a 4-day crash course with Andy on how to use the microscope and GIF, Andy went on sabbatical to Cambridge and Bristol (visiting Colin Humphreys, Paul Midgley, Alex Moodie, Joanne Etheridge, Martin Saunders, John Steeds, Roger Vincent and many others), the Universidad Complutense de Madrid (visiting Carlos Otero-Díaz), Arizona State University (visiting John Spence, Jian-Min Zuo, Mike O’Keeffe, Peter Rez and others) and to Ohio State University (visiting Hamish Fraser’s group). Then one evening – OOPSS and a few other words not worth repeating – I broke the GatanTM tilt-rotate holder by pushing the cup out while loading a specimen! I rang Andy while he was in Cambridge and he calmly asked whether I was feeling dextrous. He proceeded to lead me by phone, over a terribly crackly line, in dismantling the head of the specimen holder, re-inserting the cup and reassembling the whole thing. He was very calm and kind, probably knowing that I was absolutely terrified, and after about 30 minutes of impromptu specimen holder repair by instruction from Cambridge,

we got off the phone and the microscope session had not been lost! Among the many lessons learned from Andy: follow the checklist!

That was but one story among hundreds that I could tell about the next 6 years of being supervised by Andy. There was a second Honours project (co-supervised by Andy, Takuya Tsuzuki and Paul McCormick in Mechanical and Materials Engineering) using electron energy-loss spectroscopy (EELS) to measure plasmon energy shifts as a function of particle size in CdS quantum dots [24], and then a PhD combining synchrotron X-ray and electron diffraction measurements of structure factors in sapphire (under Andy and Victor as I have already mentioned) [12, 13, 25]. Those were some of the best years of my life and I count both Andy and Victor among my very best friends ever.

I was recently lecturing a class at Monash, when my mobile phone rang and it was Andy. I actually answered it (mentioning to the class that it was my PhD supervisor from Perth) and asked him if I could call him back afterwards. When I got off the phone, a student put up her hand and asked me why I was still speaking to my supervisor when all of the people she knew who were doing PhDs had very formal and business-like relationships with theirs and many did not like their supervisors at all. We didn’t cover any course material in that lecture because I embarked on an hour’s worth of stories from my PhD and beyond about my friendship with Andy. This is something that happens not infrequently and makes for great reminiscing for me and lots of entertainment for my students because of the multitude of very entertaining “Andy stories” I can tell.

It is said that imitation is the best form of flattery and I know from others and spot it myself sometimes that I have adopted many “Andyisms” in the way I speak and in some of my

mannerisms. Interestingly enough, I noticed the same thing in Andy in relation to Alex Moodie. As I got to know Alex over the years, I often thought to myself – ah that is where Andy got that from! The German notion of the Doktorvater definitely holds a lot of meaning across the 4 generations from Alex to Andy to me and to my own PhD students, all of whom, Andy got to know very well. My most recent PhD graduate, Ding Peng, was especially close to Andy because they did quite a bit of work together (pictured here at ACMM24 in Melbourne in 2016) on strontium titanate – Ding being a master tripod polisher and Andy requiring specimens of SrTiO₃ for the high electric field CBED experiments that made use of his modified specimen holder.

Andy officially retired in 2002 and became a Senior Honourary Research Fellow in CMCA, as it was newly named. The Centre for Microscopy, Characterisation and Analysis held a fantastic symposium in his honour. This is an opportunity to acknowledge the wonderful staff in CMM/CMCA at UWA over the years, and I know what a terrible blow it was for them to lose such a beloved member of their microscopy family. Andy was particularly instrumental in bringing to CMCA, a father of modern QCBED and someone who has since been AMMS President and a long-serving member of the AMMS executive, namely Martin Saunders. Andy meant a huge amount to the people he worked with at CMM/CMCA over the years including Lynette Lynn, Greg Pooley, Steve Parry, Jeanette Hatch, Martin Saunders, Norman Poulter, John Murphy, Sharon Platten, John Hillyer, John Kuo, Peta Clode, David Sampson, Jeremy Shaw, Brendan Griffin, Alexandra Suvorova – in no particular order and by no means a complete list and with apologies to those I have missed.

The years after his retirement saw Andy visit us (Joanne Etheridge, Laure Bourgeois and

me) at Monash many times, at times as a representative of Nanotechnology Systems (having known and been befriended with Peter Hanan for a very long time) and at times for research at the Monash Centre for Electron Microscopy (MCEM). These were wonderfully social times as the Monash/CSIRO collective who were regularly around included Alex Moodie, Harry Whitfield, Chris Rossouw, Jeff Sellar, Andrew Smith, Andrew Pogany, Peter Miller, Andrew Stevenson, Sandy Mathieson, Denis Lynch, Steve Wilkins, Tim Davis, Bob Lee, Sherry Mayo and others, including fairly regular visits from Canberra by Ray Withers.

During Andy’s first few visits, MCEM was a very small collective of Jo, Laure, Renji Pan and myself and we always enjoyed Andy’s visits so very much and he is to blame (thank) for starting a morning tea tradition that Laure and I and whoever else is around have kept up for 18 years, going virtual on a daily basis during recent times. Andy was there to witness Jo grow MCEM into a much bigger family of microscopists, engineers, instruments, and a wonderful building and he was part of the opening festivities in 2008. Around this time, Andy was back and forth between Perth, Melbourne and Columbus, Ohio as he spent time in Hamish Fraser’s group, helping with the installation of microscopes and doing research [26]. He later spent time back at MCEM to further his work on SrTiO₃ – especially when it came to the specimen preparation aspects where he worked a lot with David Vowels and Tim Williams, whom Andy had known for a long time.

In 2011, Andy was an invited speaker at the International Union of Crystallography Congress in Madrid where he presented his preliminary work on SrTiO₃. This led to a reunion with his dear friends Carlos Otero-Díaz and Ray Withers (pictured here at the congress dinner together with

Andy’s lovely partner, Kaye Negus).

Andy came for ACMM24 in Melbourne in 2016 where, as I have already mentioned, he met and got to know his “doctor-grandchildren” at the time, going on to play a significant role in the mentorship of Ding Peng (pictured with Andy on the previous page). Andy was responsible, together with Peter Hanan, for procuring a purpose-grown single crystal of CeB₆ for me back in 2006 for the purposes of using QCBED to measure bonding in this heavy fermion metal, which is a classic example of a strongly correlated electron material. This ended up forming the biggest part of Ding’s thesis which was passed and his PhD conferred, just after Andy passed away. Andy meant a great deal to Ding and a large cohort of young scientists starting out in their careers.

After Alex Moodie passed away in 2018, Andy attended IMC19 in Sydney in September of the same year and delivered (pictured here) a very interesting and entertaining perspective of Alex and the early days at CSIRO as a memorial to him. Later the same year, my wife Kate and I visited Andy and Kaye at their home at Christmas time.

Andy and Kaye invited Jo and me out for a wonderful dinner at the Weld Club in Perth when we were over there for the International Union of Materials Research Societies International Conference in Asia (IUMRS-ICA2019) last year in September. This was the last time that I saw Andy before he passed away on the 10th of March this year.

Andy was a personality who was larger than life and embraced all people, took a deep and kind interest in them and made them feel good. He was much loved and enjoyed by everyone of all ages who spent any time with him. For me he was a role-model of profound influence with simply the best attitude to life and he has always been an exemplar for how I think life is lived best. He was kind, charming, open-

minded, a quintessential scientist, an adventurer and an unparalleled gentleman. He is greatly missed.

Many people sent emails expressing their sorrow at Andy’s passing and tributes. Their names are listed as follows: Victor Streltsov (Florey Institute), Amelia Liu (Monash), Ray Withers (ex ANU, Monash), Laure Bourgeois (Monash), Les Bursill (University of Melbourne), Frank Lincoln (UWA), John Murphy (UWA), Andrew Stevenson (CSIRO), Jian-Min Zuo (University of Illinois at Urbana-Champaign), Randi Holmestad (Norwegian University of Science and Technology), John Spence (Arizona State University), Andrew Smith (Monash), Graham Chandler (UWA), Ian McArthur (UWA), Martin Saunders (UWA), Ding Peng (Monash), Tianyu Liu (Monash), Xiaofen Tan (Monash), Zezhong Zhang (University of Antwerp & University of Oxford), Yu-Tsun Shao (Cornell University), Kenji Tsuda (Tohoku University), Michiyoshi Tanaka (Tohoku University), Carlos Otero-Díaz (Universidad Complutense de Madrid).

In this reflection, I tried to name as many people as I could, and I will certainly not have covered even a small fraction of the people that Andy’s life touched. I apologise to all of you not named here, who are a part of the electron microscopy and diffraction communities.

REFERENCES

This is by no means a comprehensive list of Andy’s publications – I have simply grazed them in my reflections.

- [1] A.W.S. Johnson, “The analog computation of dynamic electron diffraction intensities”, Acta Cryst. A24 (1968), 534-543.
- [2] A.W.S. Johnson, “Analogue computation of N-beam X-ray diffraction in the Laue case”,

Acta Cryst. A31 Supp. (1975), S249-S250.

[3] A.W.S. Johnson, "Trigonal symmetry in electron diffraction patterns from faulted graphite", Acta Cryst. A28 (1972), 89-91.

[4] P. Goodman, A.F. Moodie, "Numerical evaluation of n-beam wave-functions in electron- scattering by multi-slice method", Acta Cryst. A30 (1974), 280-290.

[5] J.M. Cowley, A.F. Moodie, "The scattering of electrons by atoms and crystals. 1. A new theoretical approach", Acta Cryst 10 (1957), 609-619.

[6] Y. Zhu, P.N.H. Nakashima, A.M. Funston, L. Bourgeois, J. Etheridge, "Topologically enclosed aluminum voids as plasmonic nanostructures", ACS Nano 11 (2017), 11383-11392.

[7] P. Goodman, G. Lehmpfuhl, "Electron diffraction study of MgO h00-systematic interactions", Acta Cryst. 22 (1967), 14-24.

[8] A.W.S. Johnson, G. Lehmpfuhl, "Bloch-wave analysis for electron diffraction structure factor determination", Acta Cryst. A28 Supp. (1972), S218.

[9] A.W.S. Johnson, G. Lehmpfuhl, "Präzisionsmessung niedrig indizierter Strukturfaktoren von Calciumfluorid mit Elektronenbeugung", Z. Kristallog. 135 (1972), 468.

[10] K. Ishida, A.W.S. Johnson, G. Lehmpfuhl, "Bloch-wave analysis in electron diffraction experiments with a CaF₂ single-crystal wedge", Z. Naturforsch. A30 (1975), 1715-1729.

[11] S. Swaminathan, I.P. Jones, D.M. Maher, A.W.S. Johnson, H.L. Fraser, "Effects of Debye-Waller factors and compositional uncertainties on the 200 structure factor refinement in γ -TiAl", Philos. Mag. Lett. 75 (1997), 261-270.

[12] V.A. Streltsov, P.N.H. Nakashima, A.W.S. Johnson, "Charge density analysis from

complementary high energy synchrotron X-ray and electron diffraction data", J. Phys. Chem. Solids 62 (2001), 2109-2117.

[13] V.A. Streltsov, P.N.H. Nakashima, A.W.S. Johnson, "A combination method of charge density measurement in hard materials using accurate, quantitative electron and X-ray diffraction: The α -Al₂O₃ case", Microsc. Microanal. 9 (2003), 419-427.

[14] B. Dawson, P. Goodman, A.W.S. Johnson, D.F. Lynch, A.F. Moodie, "Some definitions and units in electron diffraction", Acta Cryst. A30 (1974), 297-298.

[15] P. Goodman, A.W.S. Johnson, "Identification of enantiomorphically-related space groups by electron diffraction - a second method", Acta Cryst. A33 (1977), 997-1001.

[16] A.W.S. Johnson, A.R. Preston, "Some notes on the selection of structural chirality by CBED", Ultramicroscopy 55 (1994), 348-355.

[17] A.W.S. Johnson, "Chiral determination: direct interpretation of convergent-beam electron diffraction patterns using the series expansion of Cowley and Moodie", Acta Cryst. B63 (2007), 511-520.

[18] A.W.S. Johnson, B.M. Gatehouse, "Convergent-beam electron diffraction symmetry from a disordered structure (Ce, Ta) Ta₆O₁₉", Acta Cryst. B36 (1980), 523-526.

[19] J. Zou, D.J.H. Cockayne, G.J. Auchterlonie, D.R. McKenzie, S.X. Dou, A.J. Bourdillon, C.C. Sorrell, K.E. Easterling, A.W.S. Johnson, "Twin structures, transformation and symmetry of superconducting YBa₂Cu₃O_{7-x} observed by transmission electron microscopy", Philos. Mag. Lett. 57 (1988), 157-163.

[20] C.L. Baker, F.J. Lincoln, A.W.S. Johnson, "A low-

temperature structural phase transformation in CuAgS", Acta Cryst. B47 (1991), 891-899.

[21] A. Gómez-Herrero, A.R. Landa-Cánovas, A.W.S. Johnson, L.C. Otero-Díaz, "Transmission electron microscopy study of Y_{1-x}□_xCr₂S₄, x-1/3 phase", JALCOM 323-324 (2001), 86-90.

[22] J.D. Fitz Gerald, A.W.S. Johnson, "A simplified method of electron microscope voltage measurement", Ultramicroscopy 12 (1984), 231-236.

[23] A.W.S. Johnson, A. Olsen, "Electron-diffraction methods", International Tables for Crystallography Vol. C, chapter 5.4 (1992). (reprinted in International Tables for Crystallography Vol. C, chapter 5.4 (2006), 537-540).

[24] P.N.H. Nakashima, T. Tsuzuki, A.W.S. Johnson, "Particle size dependence of the volume plasmon energy in cadmium sulphide quantum dots by electron energy loss spectroscopy", J. Appl. Phys. 85 (1999), 1556-1559.

[25] P.N.H. Nakashima, A.W.S. Johnson, "Measuring the PSF from aperture images of arbitrary shape - an algorithm", Ultramicroscopy 94 (2003), 135-148.

[26] A. Genç, R. Banerjee, G.B. Thompson, D.M. Maher, A.W. Johnson, H.L. Fraser, "Complementary techniques for the characterization of thin film Ti/Nb multilayers", Ultramicroscopy 109 (2009), 1276-1281.

By Philip Nakashima
21 August 2020

AMAS PRESIDENT'S REPORT

I AM VERY PLEASED TO REPORT that the August issue of Microscopy & Microanalysis Cambridge University Press includes manuscripts developed from the 15th Biennial Symposium of the Australian Microbeam Analysis Society, Brighton, Victoria, Australia, 13-15 February 2019. Australian Microbeam Analysis Society Special Section AMAS XV 2019.

Well done Colin Macrae, convenor of AMAS XV who was the guest editor for the August edition of Microscopy and Microanalysis. A big thankyou to those who contributed the manuscripts and the presentations at the AMAS Symposium in Brighton last year. The link to M&M can be found as follows:

www.cambridge.org/core/journals/microscopy-and-microanalysis/latest-issue

AMAS is a member of the International Union of Microbeam Analysis Societies, (IUMAS). IUMAS is made up of the Microbeam Analysis Societies from the USA, Europe (EMAS), Korea, Brazil, Canada, China and South Africa. Early in August I attended the IUMAS Executive meeting chaired by the IUMAS President Mike Matthews.

Dr Rick Wuhrer and Dr Colin Macrae are also members of the IUMAS Executive. IUMAS hold conferences every four years (roughly speaking). Its next meeting is hosted by the Canadian Society, IUMAS-8 due in May 2021 in Banff Alberta Canada to be held

jointly with MSC, the Microscopical Society of Canada.

The most pressing matter discussed at the IUMAS Executive meeting was the organizing for the IUMAS-8 meeting, which, due to issues relating to the COVID pandemic and travel restrictions, is now planned to be moved from May 2021 to mid 2023 once again in Banff Alberta.

Also discussed at the IUMAS Executive was a report from MAS (Microanalysis Society of America) on the virtual M&M conference held in early August this year. MAS were very pleased with the high participation of students and early career scholars at M&M.

The online format saw a significant increase in student attendance to the M&M Conference. MAS strongly encourages the participation of younger scientists and students. MAS defines an early career scholar (ECS) as an individual at the undergraduate, graduate, postdoctoral level, or an early-career professional (within first two years of initial employment).

It is these early career scholars that AMAS has a reciprocal agreement with EMAS and MAS to support to attend the IUMAS member society meetings.

The AMAS Executive met again at the end of June to decide on the form of the AMAS Symposium planned for Curtin University in February 2021.

The executive agreed to move the in person meeting to 2022 to

CONTINUED ON NEXT PAGE



Angus Netting
President
AMAS

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The most pressing matter discussed at the IUMAS Executive meeting was the organizing for the IUMAS-8 meeting, which, due to issues relating to the COVID pandemic and travel restrictions, is now planned to be moved from May 2021 to mid 2023 once again in Banff Alberta.



support ACMM27 at the University of Western Australia. AMAS will hold a series of online events early in 2021 at the time the AMAS meeting was planned.

Microscopy Australia is holding a series of consultation sessions to better understand the future microscopy and microanalysis requirements of Australian researchers.

Microscopy Australia is keen to

hear from researchers and research groups and has sent out an invitation to register and contribute to Microscopy Australia's plans for the 2021 National Research Infrastructure Roadmap:

www.micro.org.au/news-events/events

In my last report I mentioned many of the online training modules from Microscopy Australia.

In this report I wish to draw your attention to the amazing range of online information from our vendors and microscopy manufacturers from JEOL, Zeiss, Thermo Fisher Scientific, Hitachi, Bruker, Oxford and Tescan etc.

Following my report are some, only a very few, of the links to these online resources which relate to techniques, sample prep and software developments.

JEOL

IDES and JEOL - Exploring TEM Phenomena from Milliseconds to Femtoseconds

www.jeol.co.jp/en/news/seminar/2020/2020_webseminar_0820.html

Introduction to Scanning Electron Microscopy

www.attendee.gotowebinar.com/recording/5311188028618288902

JEOL UK are also running the following seminars:

Spectroscopy (EDS) in the SEM – how to find and identify impurities: register here <https://lnkd.in/deKmBhc>

Advanced Imaging and Spectroscopy and looking at tiny things: register here <https://lnkd.in/dEunJX5>

Addressing common sample issues: register here <https://lnkd.in/dE6iPAY>

Thermo Fisher Scientific

www.thermofisher.com/au/en/home/about-us/events/industrial/virtual-electron-microscopy-webinar-series.html

www.thermofisher.com/au/en/home/about-us/events/industrial/reveal-2020-virtual-events.html#eventdetailslistitem_1005963868-inner

Zeiss

www.zeiss.com/microscopy/int/microscopy-insights-hub.html

www.zeiss.com/microscopy/int/microscopy-insights-hub.html

www.zeiss.com/microscopy/us/local/zen-knowledge-base.html

www.zeiss.com.au/microscopy/local/2020webinars/zoey-webinar-series-microscopy-mondays.html

Hitachi

www.hitachi-hightech.com/us/support/training/microscopywebinars/

LMA PRESIDENT’S REPORT

HOW WE ARE ALL COPING

DURING these difficult Covid-19 times? Are you OK? Personally for me, fatigue from Zoom meetings is setting in and I am missing walking to and from work every day. Nonetheless, I am enjoying being back at the microscope on those days that I am not working from home, and supporting and training users, whilst socially distancing of course! I think we are all benefitting from new ways of communicating and learning, but we must take care of ourselves and spend some time away from the screens.

I have therefore dug out my knitting needles and acrylic paints with good intentions but have found little time yet to use them. One of our MIF alumni (Microbial Imaging Facility) at the University of Technology Sydney (UTS), Dr Solenne Ithurbide applied her artistic skills recently to create an amazing artwork of her interpretation the award-winning image of a tiny snail taken by Håkan Kvarnström – this image won first prize in the Olympus Image of The Year European Life Science Light Microscopy Award in 2018 (www.olympus-lifescience.com/en/discovery/2018-image-of-the-year-award-spotlight-1st-prize-winner-hkan-kvarnstrm-captures-the-golden-ratio/).

Kvarnström’s photo was of a micromollusc that measured only 2.2 mm and was illuminated by UV light to reveal the microalgae and cyanobacteria growing on the shell surface, which could be seen to autofluoresce in red and orange colours, respectively.

Solenne Ithurbide was inspired to take up the recent Olympus Science meets Art (#SciArt) challenge on social media that requested life science-inspired sketches and paintings for a chance to be featured on their social media pages. Solenne posted her artwork via Twitter and commented: “I chose this pic for its

hypnotic blues that make me think of the incredible colours of Ozzie’s oceans and because we all need to escape in some ways in this current time”.

Dr Ithurbide, left Australia earlier this year to take up a new postdoctoral position in Europe. Her mixed media (acrylic, watercolour and oil pastels) artwork evidently mixes both Science and Art and has inspired me to try and take some time to be creative. Watch this space!

You all also have the opportunity to be creative by entering the 2020 Light Microscopy Australia Annual Image Competition, which is now open to all Australian based microscopists! For more information and to submit your images, please go to www.microscopy.org.au

There are \$2400 worth of prizes spread over four categories (Life Sciences, Live-cell Imaging, In Vivo Imaging and Materials Sciences). I would like to extend a special thanks to Zeiss, Coherent and Optiscan for sponsoring the competition again this year. The competition closes on 23 October 2020, so you have plenty of time to select images and/or movies to enter! Good luck!

Other 2020 LMA activities include the upcoming FIJI/Image J Workshop (28–29 September 2020; Charles Perkins Centre, The University of Sydney) organised by the amazing Drs Cameron Nowell and Pamela Young!

I attended Cam’s course in Melbourne many moons ago now and found it extremely useful. This newsletter will be released close to or after the event, but thank you to Pam and Cameron for running such useful events. Registration is due to close on September 11th 2020.

Our LMA National meeting 2021 has now been pushed back to August 2021 (i.e. it will not take place in Q1 or Q2 next year) as



Assoc. Prof. Louise Cole
President
LMA

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Solenne Ithurbide was inspired to take up the recent Olympus Science meets Art (#SciArt) challenge on social media that requested life science-inspired sketches and paintings for a chance to be featured on their social media pages.

LIGHT
MICROSCOPY
AUSTRALIA

a result of the ongoing Covid19 situation. The local organising committee Drs Renee Whan and Celine Heu (UNSW, Sydney) are looking into possible conference online platforms for this event and opportunities for sponsorship.

We will be sure to keep our LMA/AMMS members updated as we know more about this event. If you want further information, please contact Celine Heu directly (c.heu@unsw.edu.au).

If you have any suggestions about what else you would like to see the LMA Special Interest Group doing, we are always interested in hearing about new ideas.

Please email your suggestions to Dr Paul McMillan, LMA Secretary (paul.mcmillan@unimelb.edu.au). For now, stay safe and well and I look forward to hearing about your artistic endeavours!



Artwork by Dr Solenne Ithurbide.

LIGHT MICROSCOPY AUSTRALIA 2020 IMAGE COMPETITION

Four Categories:
Live Cell Imaging
Life Sciences
Material
Sciences
In Vivo Imaging



\$2400 in prizes
Eight prizes to be
awarded
\$400 & \$200 prizes
for each category

Open to all microscopists based in Australia

Closing Date 5pm Friday 23rd October

Enter via www.microscopy.org.au

The Intricacy of Life V. Pragathi Masamsetti (CMRI). Winner of the Life Sciences Category, LMA 2019 Image Competition

Sponsored by:



1. Information on how to enter and prizes for the **2020 Light Microscopy Australia Image Competition ("Competition")** form part of these **"Terms and Conditions"**. Entry into the Competition is deemed acceptance of these Terms and Conditions.
2. The Competition commences for entry submissions at **9am AEST on Monday 17TH August 2020**. Entries close **5pm AEST on Friday 23RD October 2020**. No late entries will be accepted.
3. The competition will be split into four categories: (i) live cell imaging, (ii) life sciences, (iii) in vivo imaging and (iv) materials sciences.
4. Entry is open to all researchers based in Australia, and therefore does not require AMMS membership as in prior years. Employees of microscope manufacturers/companies are ineligible to enter.
5. **Each entrant may submit a maximum of THREE images and ONE movie in total.**
6. To enter, you must submit images/movies that have been taken using an optical/light or fluorescence microscope. Your image(s) must be uploaded electronically via the Googleform (and associated GoogleDrive) and submitted by the closing date of the Competition. LMA accepts no responsibility for lost, late, stolen, damaged or misdirected entries.
7. The image file format for emailing submissions can be TIFF, PDF or video format. Image files should be high resolution with a recommended file size equal to or greater than 3-4MB, and videos no larger than 100MB.
8. Valid entries may be displayed in various regional institutions with LMA representation, with entrant's name, title of entry and a brief image description.
9. Each entry must be the original work of the person entering the competition and all entrants agree that their entry does not contain any material that infringes anyone else's copyright. The entry will not have been previously awarded a prize in another or similar competition category in a previous year.
10. Each entrant grants LMA the right to reproduce, publish, transmit or otherwise communicate to the public their entry, in whole or in part, in or using any media for any purpose without permission or payment.
11. All valid entries received by **5pm Friday 23RD October 2020** will be individually judged by a panel appointed by LMA who, at their discretion, will select images for display and of these the **best entries will be selected as prize winners**.
12. The winner(s) of this Competition will win ONE of the fabulous prizes kindly donated by our category sponsors.
13. The prize winners will be notified by email if they are one of the prize winners by mid-November 2020. The judges' decision is final and no correspondence, including in the event of a dispute, will be entered into.
14. All entries will be judged having regard to the overall aesthetics of the image, technical difficulty in obtaining the image, research relevance, originality and suitability for the competition.
15. The prize is not transferable, exchangeable or redeemable for cash.
16. Any tax liability for accepting the prize is the responsibility of the winner.
17. LMA reserves the right to disqualify any entrant for submitting an entry, which is not in accordance with these Terms and Conditions.
18. If for any reason the Competition is not capable of running as planned, LMA reserves the right to modify the terms of the competition, including the prize and these Terms and Conditions.
19. LMA will not be liable for any injury, loss or damage of any nature whatsoever (including but not limited to indirect or consequential loss) which is suffered or sustained as a result of, or in connection with receiving, taking or using any prize, except for any liability which cannot be excluded by law.

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Affiliated Special Interest Groups

The Australian Microscopy and Microanalysis Society Inc.

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The Society is a non-profit organisation dedicated to the promotion and advancement of the knowledge of the science and practice of all microscopical imaging, analysis and diffraction techniques useful for elucidating the ultrastructure and function of materials in diverse areas of biological, materials, medical and physical sciences. The Society's major activities are the convening of multidisciplinary conferences and workshops, the publishing of a quarterly newsletter, and the co-ordination of activities with similar groups within Australia and overseas. AMMS Inc. is a member of the Federation of Australian Scientific and Technological Societies (FASTS), a lobby group that seeks to influence government decision-making about science and technology. Special Interest Groups are represented in FASTS by AMMS Inc.

The Australian Microbeam Analysis Society (AMAS)

Secretary: Angus Netting
secretary.amas@microscopy.org.au

AMAS concentrates on the important area of chemical analysis using microbeams and runs a symposium and workshop programme. AMAS operates its own office bearers and committee. AMAS closely co-operates with its US counterpart - the Microbeam Analysis Society - for example with exchange visits by society presidents and by students.

Light Microscopy Australia (LMA)

Secretary: Paul McMillan
secretary.lma@microscopy.org.au

Light Microscopy Australia is a national special interest group holding an annual conference along with local meetings, workshops, seminars or keynote lectures independently or in conjunction with AMMS. Members are notified of meetings, activities and microscopy information. Our objective is the advancement of the science and techniques of light microscopy including: specimen preparation, optics and Image formation, image analysis and visualisation,

instrumentation and, training and career development. Applications include Biology, Biotechnology, Pathology, Physics, Chemistry, Electronics, Metallurgy, Minerology, Materials, Nanosciences, Teaching or other sciences. Membership of the LMA is free after joining AMMS and ticking the LMA membership box on the AMMS application form.

CryoOz - Cryo-EM down under

The aim of the new CryOz group is to sustain and grow the Australian cryo-EM community, share expertise and resources, and provide a forum for early career and established researchers in the Cryo-EM field. CryOz runs the CryOz conferences (CRYOZ.org) and dedicated Cryo-EM hands-on workshops.

The Australasian Electron Microscopy Email Newsgroup (AUSTEM)

AUSTEM provides a rapid means of communication between Australasian microscopists for meeting and course announcements, problem solving, equipment for sale, donation or wanted, and other issues of regional concern (as compared to the world wide Microscopy Listserver).

WANT TO BECOME AN AMMS MEMBER?

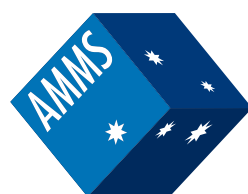
Email Jamie Riches, AMMS Treasurer: jamie.riches@qut.edu.au

Professional membership:
1 year AU\$50 // 2 years AU\$90

Student | Junior Technical | Retired:
1 year AU\$25 // 2 years AU\$45

Copies of the respective Constitutions /Articles of Association are available from the relevant Secretary. Membership in each of the Special Interest Groups is administered via membership applications to AMMS Inc. Membership of AMMS Inc is a necessary requirement for membership of any of the Special Interest Groups.

For more information visit www.microscopy.org.au

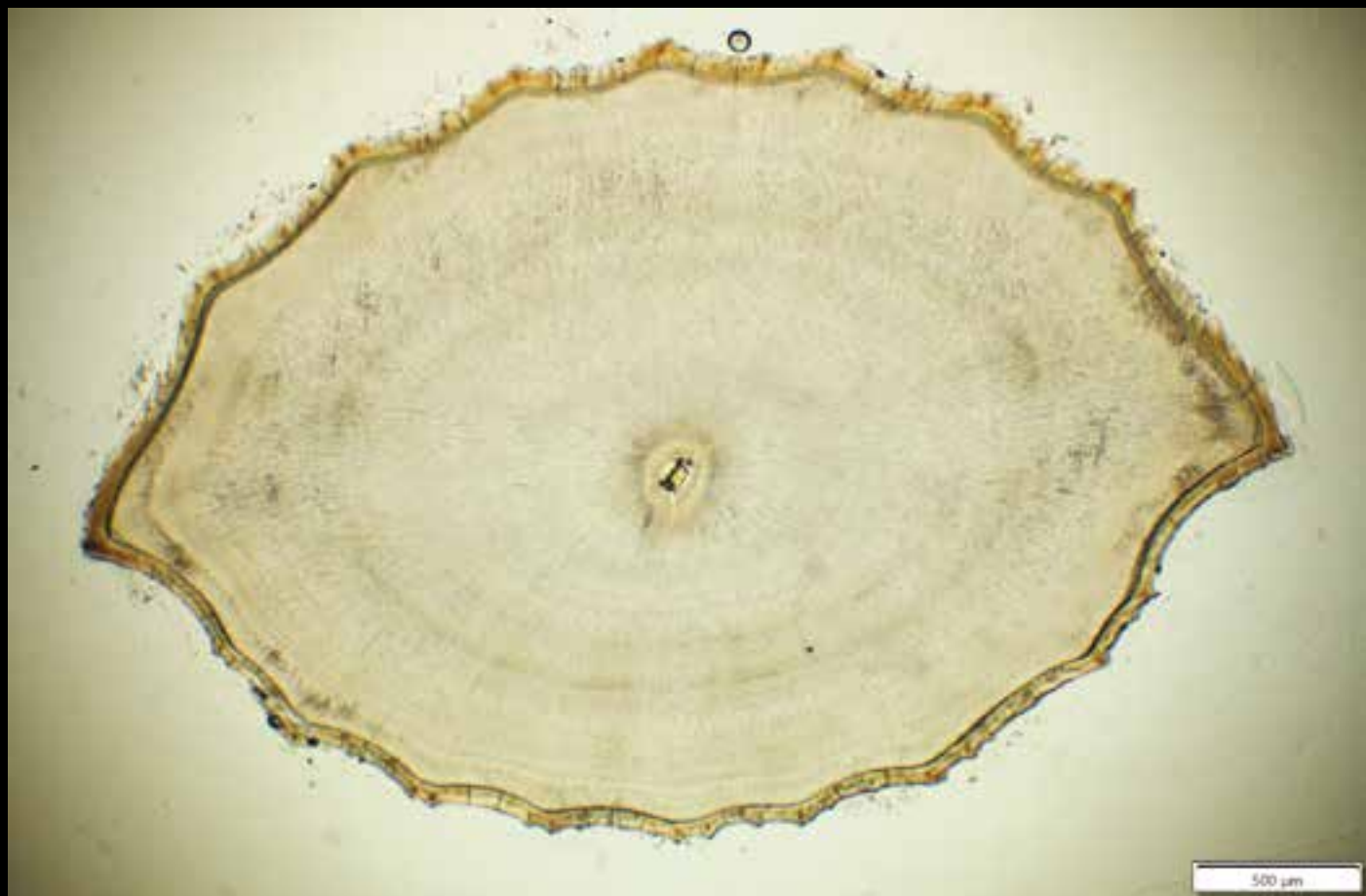


Australian Microscopy & Microanalysis Society

AMMS CORPORATE MEMBERS



IMAGES FROM OUR MEMBERS



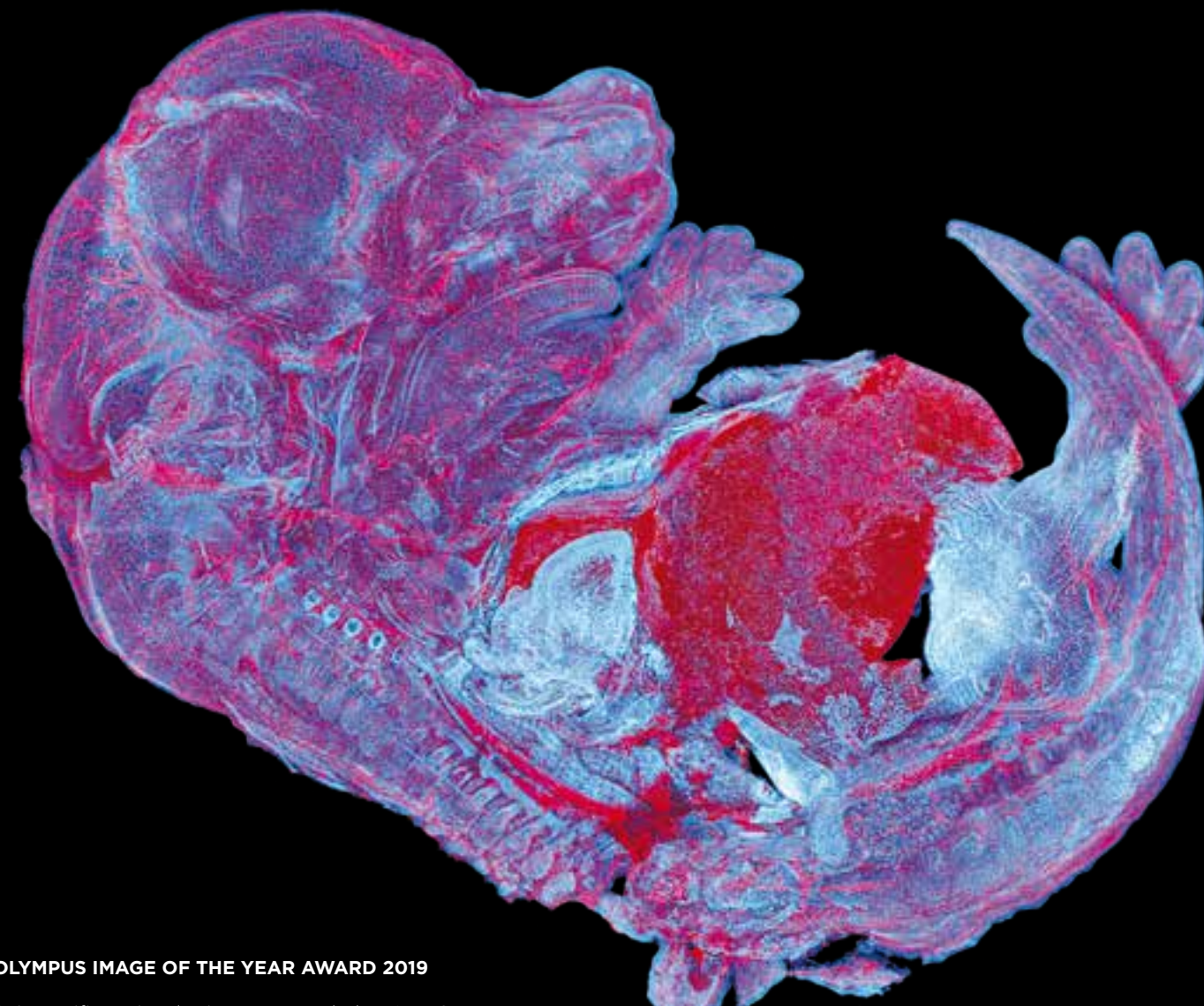
ABOVE: CP2 x4

Transverse cross-section through a crocodile (*Crocodylus porosus*) tooth crown, magnified 40x. The thin layer surrounding the tooth is enamel, whereas the tissue within is dentin. This is a sample from Darwin, NT, and is a part of a project studying incremental lines in modern and fossil crocodile teeth to understand how crocodile skeletal development changed through time in Australia.

RIGHT: CP5 x20

Image taken from the same project and sample, but taken at 200x mag. Taken using transmitted light and showing the enamel and dentinal tubules underneath.

Credit: Bryce Campbell (Australian National University (ANU)), Julien Louys (Griffith University), Justyna Miskiewicz (ANU).



OLYMPUS IMAGE OF THE YEAR AWARD 2019

Asia-Pacific regional prize was awarded to AMMS member Howard Vindin (Australia).

This remarkable image shows the autofluorescence of a mouse embryo with 950 tiles stitched together.

For further details on the award winners please visit www.olympus-lifescience.com/en/landing/ioty-2019/

Selectris and Selectris X Imaging Filters

Experience the thrill of atomic-resolution cryo-EM

Designed for stability and speed, the Thermo Scientific™ Selectris™ and Selectris X Imaging Filters are post-column imaging filters that improve the contrast of TEM images, resulting in high-resolution structures up to atomic resolution.

The zero-loss filtering of the Selectris Filters removes noise caused by inelastically scattered electrons, producing an increased signal-to-noise ratio (SNR) and improved contrast. Designed for high stability, ease of use, and paired with the latest generation Thermo Scientific Falcon™ 4 Direct Electron Detector, Selectris Filters enable you to obtain high-resolution structures quickly, increasing the productivity of your single particle analysis (SPA) and cryo-electron tomography workflows.

With the Selectris Filters, zero-loss energy filtering is straightforward due to the thorough integration of software and hardware along with extensive automation and exceptional stability. Every mechanical and electron-optical element has been designed for stability and reproducibility, enabling the unattended and reliable acquisition of large datasets with narrow energy slit widths (<10 eV). Particularly for the thin samples often used in SPA, the capability to use <10 eV slits provides an additional boost in contrast, enhancing resolution and throughput.

Designed for high stability, the zero-loss peak position of the Selectris Filters is insensitive to temperature variations in the environment, eliminating the need for frequent tuning. On the rare occasion that filter tuning is necessary, it can be completed automatically within minutes; this ensures smooth daily operation and efficient data acquisition.

Selectris Filters are available on the award-winning Thermo Scientific Krios™ and Glacios™ Cryo-TEMs and are fully integrated into the instruments' operation and application software.

Key Benefits

Designed for stability

- Contrast enhancement on thin and thick samples thanks to <10 eV zero-loss energy-filtered transmission electron microscopy (EFTEM)
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- Minimized sensitivity to temperature variations

Straightforward operation

- Fully integrated in Thermo Fisher Scientific instrument operation software as well as Thermo Scientific EPU and Tomography Software for data collection
- Filter tuning is only needed occasionally and is completely automated
- No need to interrupt data collection for zero-loss centering

Falcon 4 Direct Electron Detector

- High detective quantum efficiency (DQE) across the spatial frequency range
- High speed: can routinely produce 300+ movies/hour
- Built-in electron event representation (EER) for full temporal resolution (240 frames per second), no need for fractionating at time of acquisition
- Super-resolution up to 16k x 16k without file-size penalty
- Efficient file-size compression

Selectris X Filter – taking the next step toward atomic resolution

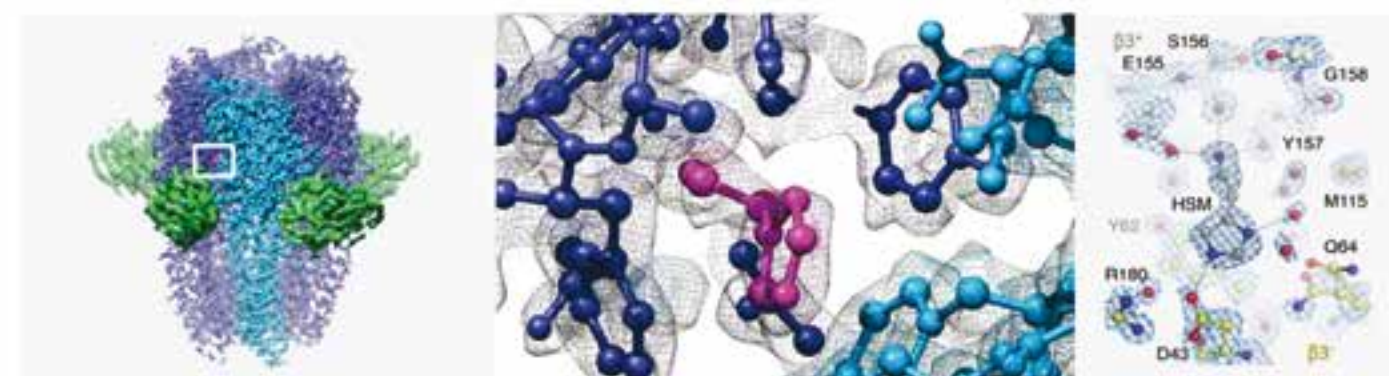
Expanding on the stability, ease-of-use, and performance of the Selectris platform, the Selectris X Imaging Filter offers an even more sophisticated electron optical system for further aberration correction. This results in extremely low distortion characteristics in both the image and energy domains, opening the way to true atomic-resolution structures in single particle analysis cryo-electron microscopy (cryo-EM).

System requirements

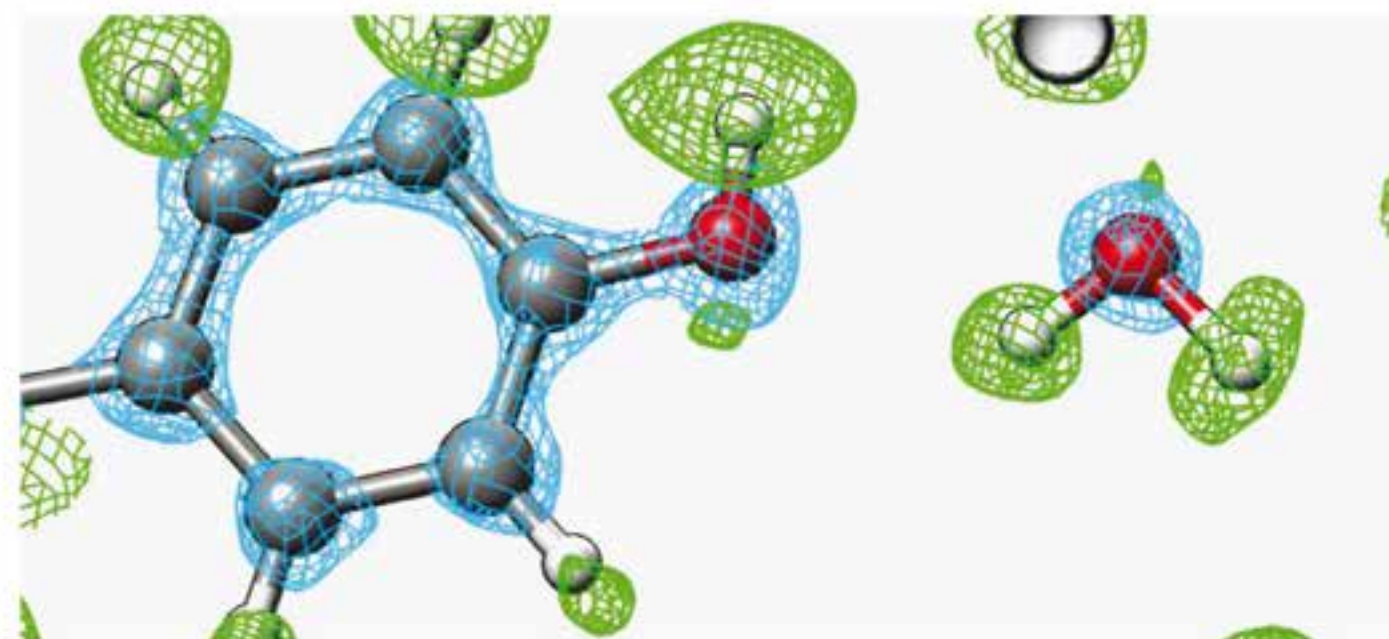
Selectris and Selectris X Filters are available on new Krios and Glacios Cryo-TEMs. Retrofits to existing microscopes are possible on most Thermo Scientific cryo-TEMs operating under Windows 10. An extended datasheet with additional specifications is available upon request.



The Thermo Scientific Selectris Imaging Filter.



GABA_A receptor resolved at 1.7 Å shown from a side view (left). Detail of the binding pocket is shown in the middle. Histamine coordination and a number of water molecules (red spheres) are shown on the right. Adapted from Nakane, T. et al. bioRxiv (2020), CC-BY 4.0. Image courtesy of Andrija Sente and Radu Aricescu, MRC-LMB Cambridge.



Apoferritin resolved at 1.2 Å, showing hydrogen atoms in the difference map (green densities). The hydrogen bonding network around Y32 and water-302 is shown. Image courtesy of Sjors Scheres, MRC-LMB Cambridge and Abhay Kotecha, Thermo Fisher Scientific.

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ONE BIG STEP FURTHER TO A FULL CRYO SUITE AT THE CENTRE FOR ADVANCED MICROSCOPY/ANU

The Australian National University (ANU) installs first National Collaborative Research Infrastructure Strategy (NCRIS) supported instrument: Zeiss Crossbeam 550 Focused Ion Beam – Field Emission Scanning Electron Microscope (FIB-FESEM).

THE CENTRE FOR ADVANCED IMAGING (CAM) recently welcomed the installation of the Zeiss Crossbeam 550 FIB-FESEM on its path to develop a fully equipped correlative cryo platform.

The Crossbeam comprises a Leica cryo stage and transfer system, which will facilitate cryo block face imaging as well as the production of on-grid transmission electron microscope (TEM) lamella for viewing in the JEOL 200kV CryoARM (NCRIS co-funded; expected March 2021).

For a correlative workflow, additional upgrades include a new Linkam Scientific cryo stage (CMS196) for the Zeiss LSM800/ Airyscan and the Zeiss Atlas 5 and ZEN Connect software, which will facilitate an enhanced workflow for correlative cryo light microscopy and tomography/3D cryo volume imaging.

The Crossbeam comprises a Leica cryo stage and transfer system, which will facilitate cryo block face imaging.

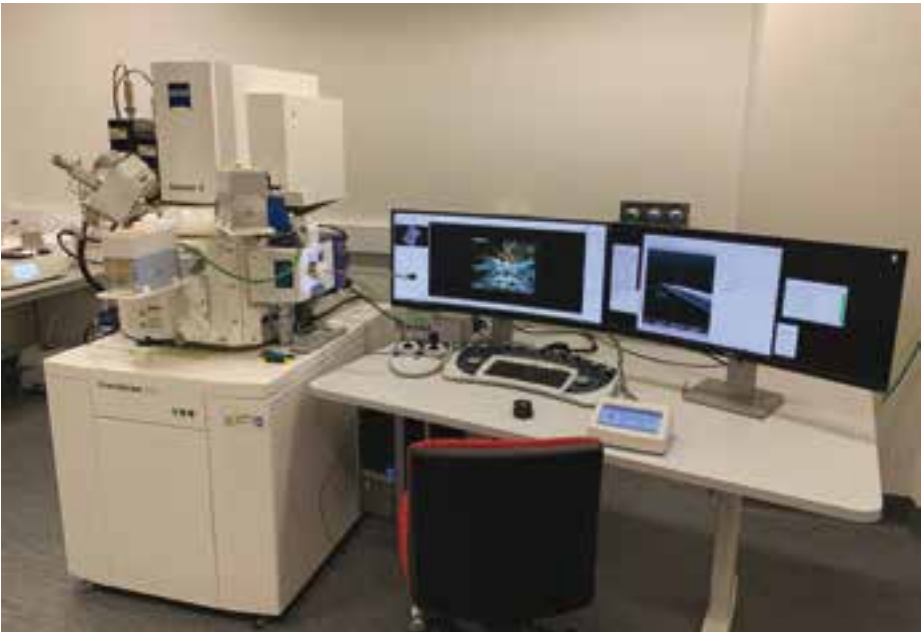


Figure 1: The Zeiss Crossbeam 550 installed at CAM.

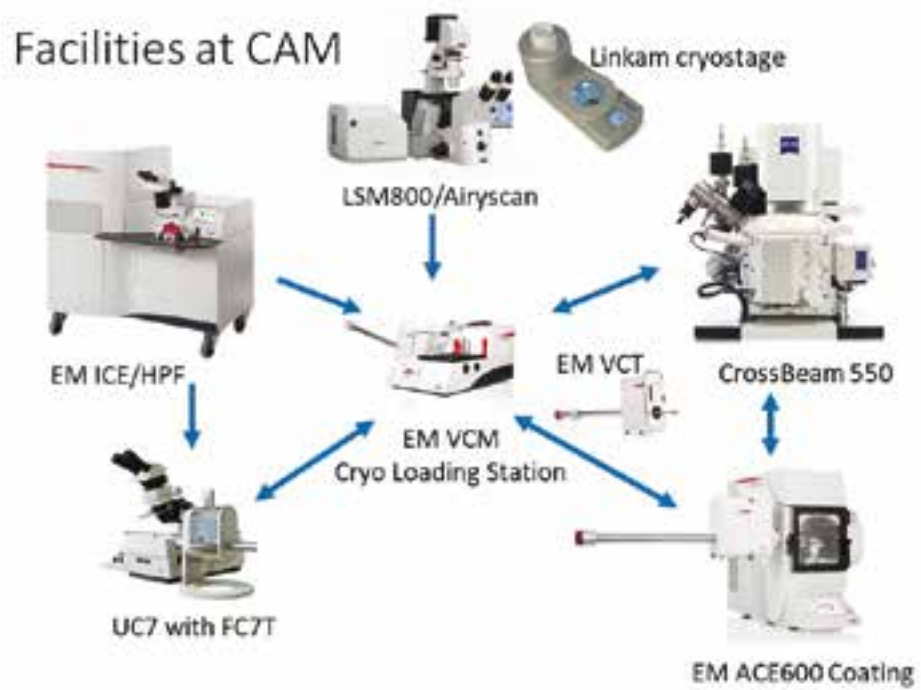


Figure 2: CAM Cryo capabilities showing workflow options.

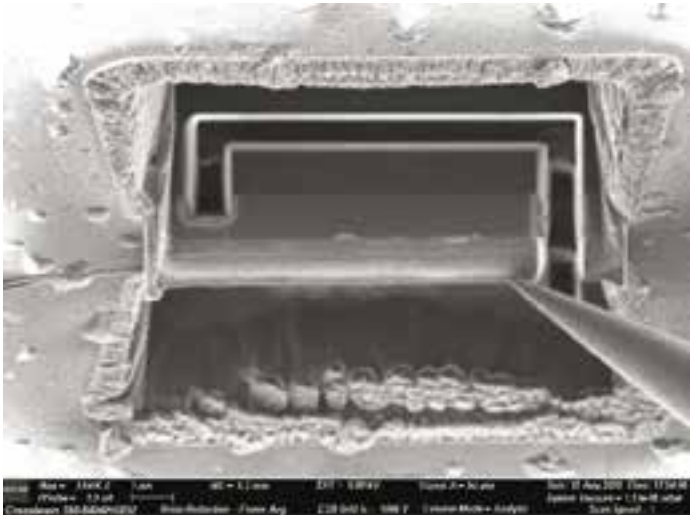


Figure 3: First lamella prepared at CAM, ready for lift out.

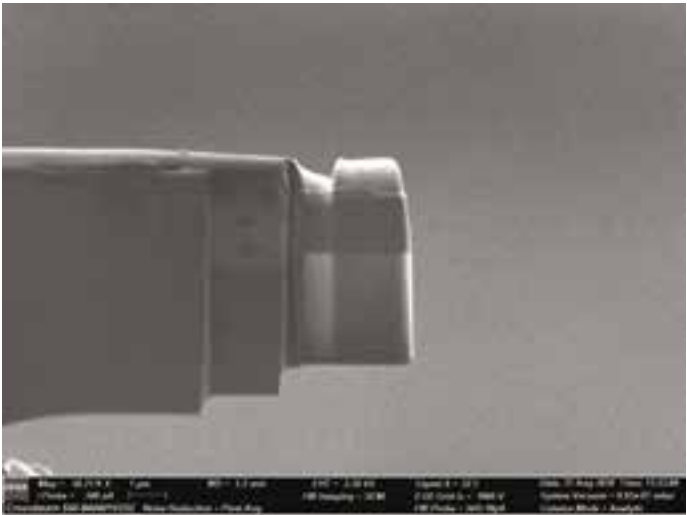


Figure 4: Final polishing of first lamella. White region is 50-60nm.

The new Crossbeam system features the Gemini 2 Electron column as well as the new Ion-sculptor FIB column. By making use of the FIBs improved low

voltage performance at below 5kV, the Crossbeam 550 is also able to generate room temperature TEM lamellae of less than 50nm by keeping amorphisation damage

to a minimum. A Kleindiek manipulator supports both room temperature and cryo lamella lift out solutions.





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ZEISS INTRODUCES ADVANCED RECONSTRUCTION INTELLIGENCE FOR ITS XRADIA 3D X-RAY MICROSCOPES



New Reconstruction Algorithms Increase Throughput with Improved Image Quality

ZEISS INTRODUCES THE ADVANCED RECONSTRUCTION TOOLBOX for its industry-leading ZEISS Xradia 3D X-ray microscope and computed tomography systems.

With the Toolbox, two modules are announced: an upgraded ZEISS OptiRecon for iterative reconstruction, and ZEISS DeepRecon, microscopy's first commercially available deep learning reconstruction technology.

ZEISS Advanced Reconstruction Toolbox, available on ZEISS Xradia 3D X-ray platforms, will enable customers to continuously access the latest technologies available for reconstruction, providing flexible strategies as researchers' imaging needs evolve. Based on advancing reconstruction technologies beyond the typical "filtered back projection" or Feldkamp-Davis-Kress (FDK) algorithms, this AI-based toolbox enables fewer projections, reducing scan times by up to 10X, depending on module and material. These developments allow improved data collection and analysis for faster decision-making.

At the same time, both ZEISS OptiRecon and ZEISS DeepRecon modules retain image quality, or offer greatly improved image quality for many applications. The traditional challenge of choosing either image quality or sample throughput has been resolved with these new capabilities.

ZEISS OptiRecon allows researchers to achieve superior interior tomography or throughput on a broad class of samples with improved contrast-to-noise ratios. ZEISS DeepRecon increases speed



Advancements in image reconstruction intelligence extend 3D X-ray technology to a wide range of manufacturing, process, and quality control applications.

by up to an order of magnitude for sample classes with repetitive workflows, making 3D X-ray microscopy even more attractive as a solution for manufacturing, process, and quality control applications.

Professor Dr. J.H. Shim, of Dongshin University in South Korea, formerly principal researcher in the electronics industry, speaking of a typical research application, said, "Only ZEISS enables the visualization of the polymer separator in such a short scan time and with such a small number of projections. OptiRecon and DeepRecon are fantastic applications for industry battery customers."

According to Daniel Sims, Head of ZEISS X-ray Microscopy in Pleasanton, California, "These unique offerings will enable our customers in industry and

academia to enrich their research, accelerate their time to results, and ultimately extend the capability of, and their return on investment in, their ZEISS Xradia microscopes."

ZEISS Advanced Reconstruction Toolbox, and the optional ZEISS OptiRecon and ZEISS DeepRecon modules, are immediately available for upgrade on existing ZEISS Xradia Versa and Context microscopes, enhancing the capability of installed systems, as well as on new ZEISS Xradia X-ray microscopes.

For further information please contact:

Carl Zeiss Pty Ltd
Microinfo.au@zeiss.com
www.zeiss.com.au

THE COMPANY OF BIOLOGISTS AND JOURNAL OF CELL SCIENCE LAUNCH FOCALPLANE, A NEW MICROSCOPY COMMUNITY SITE



FocalPlane is a trusted online meeting place to connect people, products, resources and information from the microscopy community.

MICROSCOPY IS A DISCIPLINE THAT UNITES biologists across all areas of research. A frequently cited difficulty is the gap in knowledge sharing between microscopy experts and non-experts.

Technical language can make the field feel exclusive and intimidating for those wanting to make use of current microscopy techniques. In response, The Company of Biologists and Journal of Cell Science have created a new community resource.

FocalPlane is a community website for microscopists and biologists alike to share microscopy news, events and resources.

A Scientific Advisory Board has been appointed to support the site alongside its own dedicated Community Manager.

Each of the five Advisory Board members bring their own microscopy specialism, making FocalPlane a centre of expertise.

"We've been looking forward to creating this resource for a

long time, to bring the biological research community [together] with the optical microscopy development community," says Advisory Board member, Professor Ricardo Henriques (University College London, UK).

The community site is free to access and users can register for a free account to post their own contribution. FocalPlane will host news, interviews, opinions, tools, job listings and events to help promote interactions and foster connections.

"We encourage you to make the site part of your online routine, and look forward to many interactions with you all," says Sharon Ahmad, Executive Editor, Journal of Cell Science.

FocalPlane is the third community site launched by The Company of Biologists, following in the successful footsteps of the Node and preLights.

The Node, now in its tenth year, serves the developmental biology community, whereas preLights is a preprint highlighting service featuring a team of over 200 early-

career researchers.

Journal of Cell Science, which hosts the FocalPlane site, has a long history of publishing papers relating to microscopy. The journal was established in 1853 as 'Quarterly Journal of Microscopical Science' and the archives showcase the evolution of microscopy over time.

ABOUT THE COMPANY OF BIOLOGISTS

The Company of Biologists is a not-for-profit publishing organisation dedicated to supporting and inspiring the biological community.

The Company publishes five specialist peer-reviewed journals: Development, Journal of Cell Science, Journal of Experimental Biology, Disease Models & Mechanisms and Biology Open.

It offers further support to the biological community by facilitating scientific meetings, providing travel grants for researchers and supporting research societies.

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LAUNCHING MICROSCOPY PRODUCTS IN THE VIRTUAL WORLD

By Pat Trimby, Oxford Instruments Nanoanalysis, UK

I HAVE ALWAYS ENJOYED ATTENDING THE annual Microscopy & Microanalysis (M&M) meeting in the US. As a scientist and microscopist, it still ranks as the best place to check out all the new technological and commercial developments, whereas as an exiled member of AMMS and AMAS, it's a great opportunity to catch up with my many Australian friends and ex-colleagues who typically attend the meeting each year.

Nowadays, as a product manager at Oxford Instruments Nanoanalysis, it remains the flagship meeting that exerts significant control over our product development timetable.

We always want to be able to launch new products at M&M, and our time at the meeting is usually spent running back-to-back demonstrations, giving scientific presentations about new technologies and applications, developing networks with other company representatives and, of course, meeting with our customers. It's an expensive, exhausting but ultimately rewarding week.

But not this year. For the first time, M&M was a purely virtual meeting - a step into the unknown for many of us. However, product development still goes on and we, as planned, had 2 major product launches at the meeting: our new AZtecWave Wavelength Dispersive X-ray Spectrometry (WDS) system and Symmetry S2 - a new, faster version of our existing Symmetry electron back-scatter diffraction EBSD detector.

Now that the dust has settled, we can look back at the meeting and assess how it all went. Is it possible to launch products and run demonstrations on a virtual



Figure 1: A screenshot of the new AZtecWave user interface, here showing the intuitive layout of the standards definition step. Note the graphical representation of the WDS spectrometer status in the "Mini View" to the lower right.

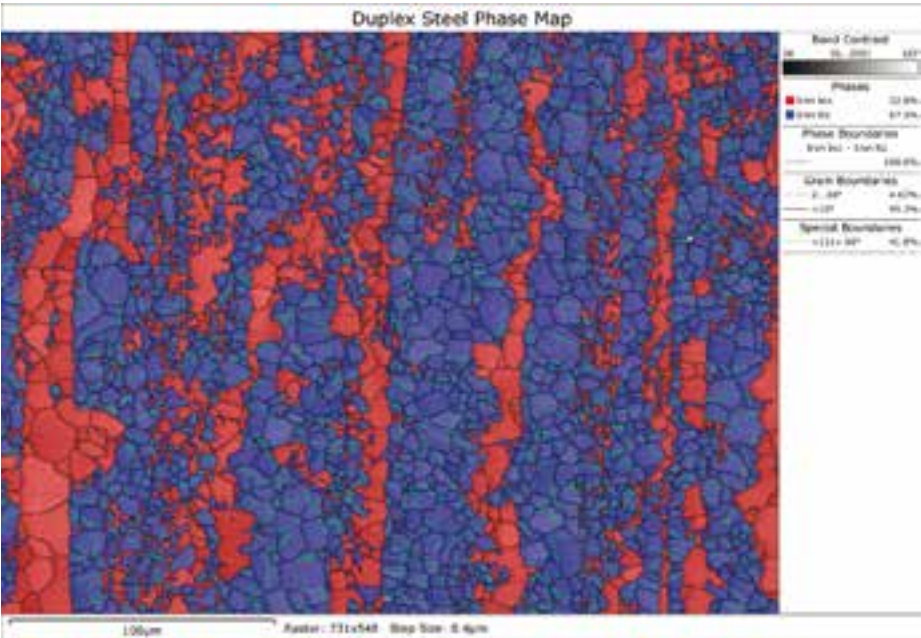


Figure 2: EBSD phase map from a duplex steel sample, collected using the Symmetry S2 detector in only 84 seconds.

platform? Are we looking at virtual conferences as an approach that can work well, even in a post-Covid world? Was it as exhausting as a normal M&M week?

As in any normal year, our planning for M&M started pretty soon after the previous year's meeting finished - we make sure that we have the right booth space

reserved, we plan the platform and poster presentations so that we can submit abstracts in time for the February deadline and, of course, we put pressure on our development teams to make sure that our headline products are going to be ready for the Big Show.

The sudden arrival of lockdown

across the world threw many of these plans into doubt but, unbeknownst to us at the time, it also helped to prepare us for what was to come.

We quickly became used to working remotely: development continued at essentially the same pace as before, marketing shifted to more virtual platforms (websites, blogs, webinars and so on), and we developed expertise in remote microscopy and, importantly, in running remote demonstrations.

Suddenly the technological foibles of Zoom, Teams and Skype were not so daunting, so when it was announced in May that M&M would be held as a virtual conference, we felt confident that Oxford Instruments could still use the meeting to successfully launch our new products.

The months of June and July were frantically spent preparing material for our website, for our virtual exhibition booth and for the presentations that we had lined up, whilst at the same time trying to get detailed information about the format of the meeting.

Instead of the live demonstrations that we would normally hold on our own booth at the M&M exhibition, we used 6 microscopes in our laboratories in the UK and US to run remote demonstrations of our new and existing products.

Interestingly, over the course of the conference week, we actually gave more demonstrations this year than in previous years, probably in part because we could be more flexible with our timings (although I didn't envy my colleagues who had demonstrations booked in the 6:00-7:00 am slot, aimed at some of our Asian customers).

Only time will tell if the impact of remote demonstrations matches that of in-person sessions, but the initial signs are very encouraging.

During the conference we ran some "Spotlight sessions" that focussed on our 2 new products, AZtecWave and Symmetry

S2. These were live events, incorporating on-scanning electron microscopy (SEM) demonstrations, and so were quite challenging given that we had only a strict 30-minute window in which to convey our message. However, in both cases, we felt that the format worked well, and you can re-watch both presentations and demonstrations on our website at www.nano.oxinst.com/library/demo-videos

So, what is so special about these new products? For our new WDS system, AZtecWave, it is the intelligent way in which the power of a fully-focussing WDS detector (as used on dedicated electron microprobe systems) is incorporated into the speed and convenience of our latest energy dispersive X-ray spectrometry (EDS) system, AZtecLive. This makes it the only system to achieve true microprobe-WDS spectral resolution on an SEM. We are increasingly confident that the significant work that we have put into the quantification "Tru-Q" algorithms in our EDS software enables us to analyse major element compositions with WDS-precision.

However, when there exists a significant X-ray peak overlap or when you need to measure trace element compositions, then you need the resolution and detection power of WDS. As you can see in the aforementioned video, the demonstration showed how trace elements (in this case Si and Co) required analysis using WDS, and how the software guides the user through the set-up of acquisition times, beam current measurement, background signal collection and quantification.

In less than 3 minutes, using a combination of both EDS and WDS, the user has measured the composition of this sample to microprobe precision. For anyone used to using our AZtec interface, the layout is instantly recognisable and intuitive, as shown in figure 1, bringing WDS-precision to many laboratories that cannot justify

the significant expense required to purchase and manage a full electron microprobe microanalysis system.

The new Symmetry S2 EBSD detector is all about speed. This system is now capable of analysing samples at speeds in excess of 4,500 indexed patterns per second (pps): to give you an example of what this means in practical terms, we can measure the grain size in samples to international standards in less than 90 seconds!

The phase map shown in Figure 2 took 84 seconds to acquire (at 4,725 pps) and, once the twin boundaries have been excluded, contains a total of 2,728 grains - significantly more than the minimum value of 500 grains recommended in various standards, such as ASTM E2627.

However, a key strength of this detector is its sensitivity: the phosphor screen is coupled to the high-speed complementary metal-oxide-semiconductor (CMOS) sensor using fibre-optics, ensuring minimal loss of signal through the whole analytical process. This ensures that we don't require high beam currents in order to analyse our samples and therefore don't compromise on the resolution and performance of the SEM: the data shown in figure 2 used a beam current of 16 nA, well within "normal" operating conditions for a modern thermal field emission gun scanning electron microscope (FEG-SEM). If you watch the Spotlight Session video, you will also see that we make quite a big deal about the fact that this is the only genuine "all in one" detector on the market today. We feel that this is a very important facet of the S2 detector: ask anyone who has used EBSD for some time, and they will tell you that you never really know what material or analysis type you'll be confronted with in the future. Having the flexibility in a detector to cope with high angular resolution studies, routine high-speed analyses, extra-large samples or challenging, beam-sensitive materials is a real bonus

that will end up saving a laboratory both time and money.

So, was the virtual conference a success? During the plenary session on the first morning, when storms in the US had knocked out some internet bandwidth and everyone across the world was having problems viewing the presentations, we all feared the worst. But credit to the Microscopy Society of America and their technical staff, as the teething problems were quickly resolved, and the conference settled into

the normal M&M routine of varied platform sessions mixed with commercial events.

There were more delegates registered than the previous year, and I feel certain that everyone listened to more talks than ever before, as we could access the presentations in our own time and use the scheduled timetable to connect to the speakers. And, as at a normal M&M, it was still exhausting – the sessions were running late into the evening UK time, and I think everyone was

pretty drained by the end of the week. But was it as rewarding? Ultimately, I don't think so – I missed those chance encounters with friends and former colleagues, the lunches with someone you've not seen for 5 years or, in my case, the chance to find out how things are going with everyone in Australia. Let's hope we can meet up next year in Pittsburgh, but I wouldn't be surprised if all future M&M's will have been shaped, at least in part, by the unique experience of 2020.

If you are interested in a remote demonstration of any of our products, please contact Nanospec Pty Ltd at enquiries@nanospec.com.au or call (07) 4059 0784 and we'll be in touch.

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Discover our
full suite of
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SCANNING THE STARS

SAND IS AN INTRIGUING MATERIAL AND until you look closely you may not appreciate how each grain is truly unique and might not be what you expect.

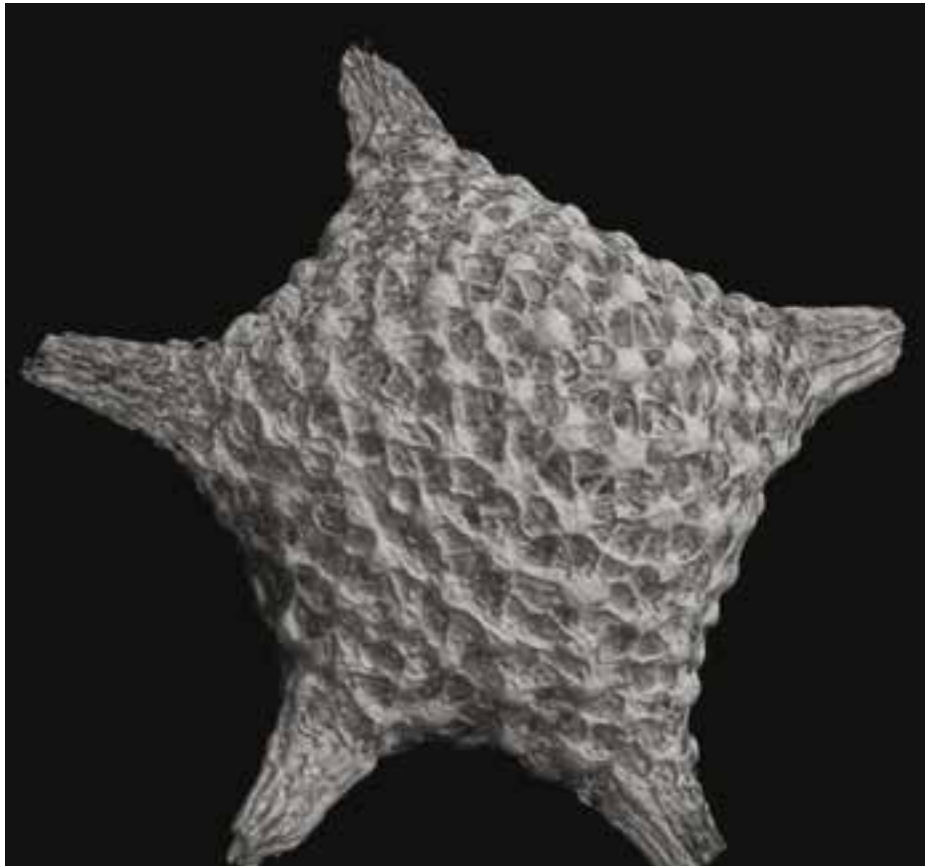
Meriam artist, Gail Mabo had been invited to a residency at the Art Gallery of New South Wales in February 2020 where she would create an artwork entitled Tagai, incorporating scanned and printed sand grains taken from the beach of Mer (Murray Island), the land of her people and notably, her father, Eddie Koiki Mabo.

After carefully looking at individual grains in a handful of sand under an optical microscope Gail made a selection of star-shaped grains that were carefully mounted for micro-computed tomography (micro-CT) scanning at the Microscopy Australia facility at the University of Sydney.

From these scans a 3D model of each of the grains was generated by the Sydney Manufacturing Hub and printed at an enlarged scale for inclusion in her artwork – a bamboo star-map of the constellation Tagai.

Torres Strait Islander culture and spirituality are closely linked to the stars and the stories of Tagai, whom the Torres Strait Islander peoples recognise as the creator of the world.

Torres Strait Islander law,



customs, and practices are shaped by stories of Tagai.

The knowledge of the stars and sea provide the Torres Strait Islander people with valuable information regarding changes in the seasons, when to plant gardens and hunt for turtles or the manatee-like dugong, and how to navigate the seas.

Star maps like this were central to the successful land title claim instigated by Edie Koiki Mabo.

Within the left hand of Tagai is the Southern Cross, and a particular star within the constellation is named Koiki in recognition of Eddie Mabo's service to the traditional owners of the lands of Australia.

There is a moving video of Gail taking about her artwork and the significance of the stars at: <https://togetherinart.org/gail-mabo-under-the-stars> or <https://youtu.be/qb7WO87Ewug>

SWIFT INSTRUMENTS

In-situ Characterisation of Metallic Samples by Swift Tension / Compression Stage

IN SITU MECHANICAL CHARACTERISATION HAS BECOME a valuable technique in materials research, allowing researchers to make microstructural observations while conducting conventional tension and compression tests.

However, it can be difficult to fit a proper stage inside the confined chamber of a modern scanning electron microscope (SEM), alongside other instrumentation. To solve this problem, Swift Instruments have developed a range of versatile, powerful and flexible in situ stage's for today's SEMs.

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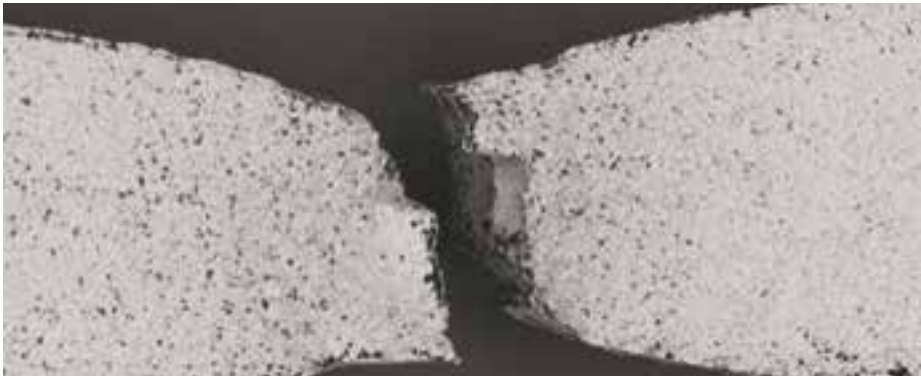


Figure 1: The real-time in situ testing of a metallic sample by using Swift stage (top) and the SEM characterisation (bottom).



Figure 2: The Swift stage with tilted sample jaw for SEM and EBSD characterisation.

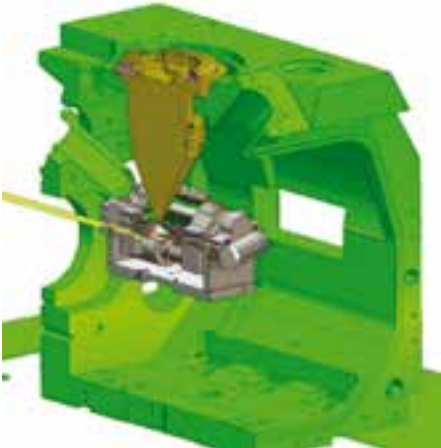


Figure 3: CAD design for accurate fitting of unique SEM applications.

Australia	United Kingdom
Hin Sci Pty Ltd, Trevor Hinwood	Swift Instruments Ltd
Trevor.hinwood@hinsci.com.au, 0477 009 099	info@swift-instruments.com, +44 (0)1354 669899



Dr Richard Harwood.

3D IMAGING OF LEAVES

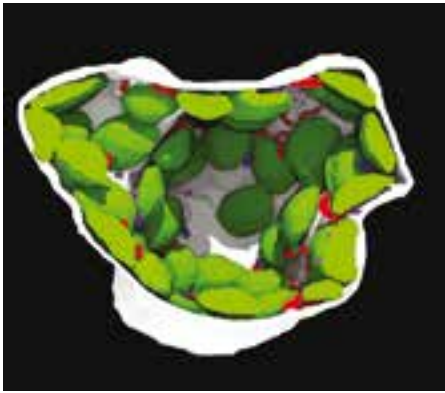
By Dr Richard Harwood – Research Associate – University of Sydney

AFTER COMPLETING MY HONOURS YEAR WITH Professor Margaret Barbour, we sat down to discuss potential PhD topics, one of which was using novel microscope techniques to image plants in three dimensions (3D).

My honours project used stable isotopes to investigate how carbon dioxide diffuses through leaves. What I learnt from my honours year was that the transit of carbon, water and light throughout the leaf are influenced by leaf anatomical features such as the amount of airspace in the leaf along with the size, shape and position of cells and organelles. The idea of expanding established plant physiology form-function relationships into 3D seemed like a really exciting project so I jumped on board! The plan at

this stage was pretty flexible: use serial block face scanning electron microscope (SBF-SEM) images to better understand leaf anatomy and how leaves work. (SBF-SEM incorporates an automated ultramicrotome within the SEM specimen chamber, collecting 2D images sequentially and allowing 3D image reconstruction) To kick things off, Margaret gave me one of her very first SBF SEM datasets; 800 images of a snippet of a wheat leaf totalling about 150 gigabytes. I sat down at my new computer and quickly found that my laptop with 4Gb of RAM and integrated graphics was not going to get the job done effectively. Computer limitations aside, the very first thing I did was separate cells and airspace for each slice. What was amazing was the stark

differences at different locations in the leaf. This observation highlighted what we expected to see: a 2D view provides a poor estimate of the complex 3D structure of leaves. What followed was more imaging and hours upon hours at the Australian Centre for Microscopy and Microanalysis (ACMM) image analysis centre learning how to obtain meaningful biological information from raw microscopy data. An exciting progression was an international meeting organized by Margaret, which brought together imaging, experimental and modelling experts to discuss how (3D) imaging could help plant physiologists better understand the dynamics of carbon and water exchange processes.

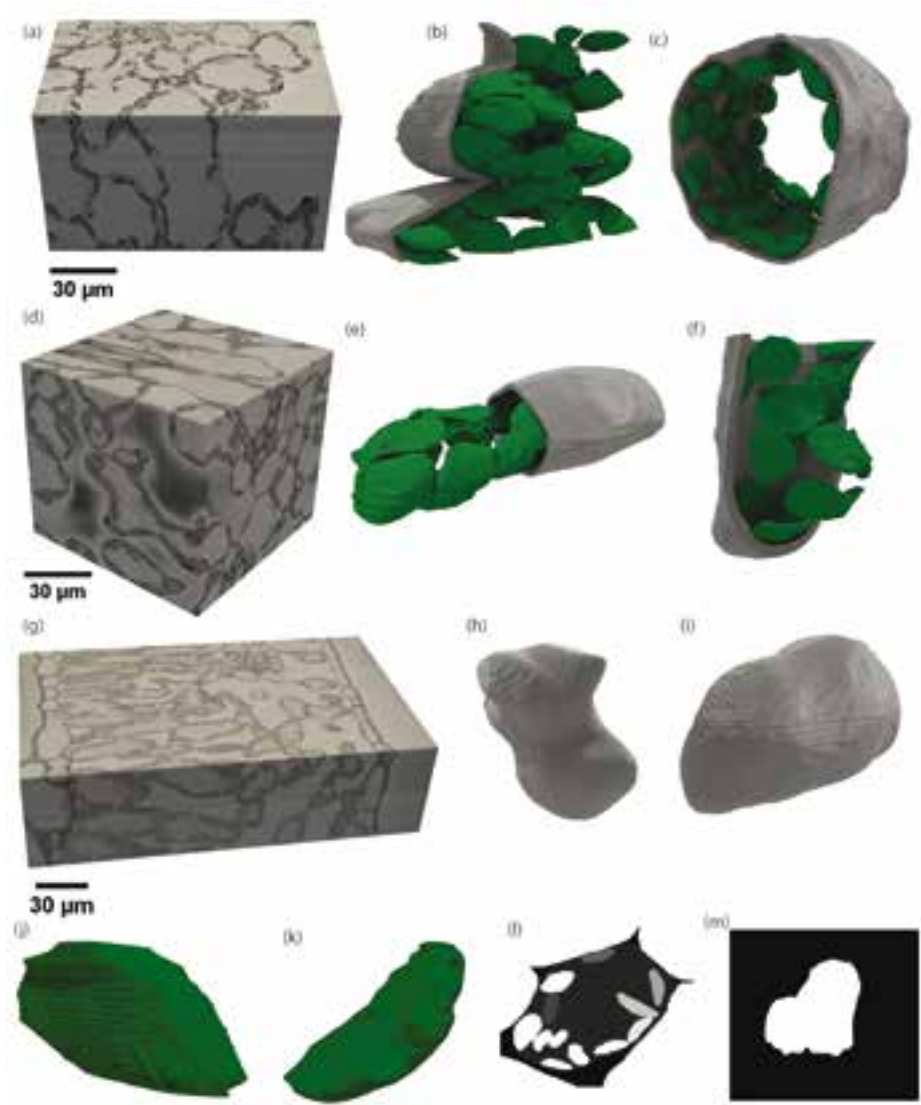


A 3D render of a wheat mesophyll cell reconstructed from SBF-SEM published in the Trends in Plant Science article. The white represents the cell wall, the green chloroplasts, purple is peroxisomes and red are mitochondria.



We made the cover!

The meeting resulted in a commentary paper “*Embracing 3D Complexity in Leaf Carbon-Water Exchange*” published in Trends in Plant Science. This was a PhD highlight for me: it was a privilege to see my work alongside such amazing co-authors and exciting to see the first ever 3D wheat cell in a publication! After the meeting, I presented our 3D leaf work at the 19th International Microscopy Congress and ComBio (Australian Society of Plant Scientists meet up), it was great to talk about the work



An overview of our 3D leaf workflow: Serial block face scanning electron microscopy (SBF-SEM) datasets (Image stacks) from high-resolution wheat (a), high-resolution chickpea (d) and low-resolution chickpea (g). 3D renders of: wheat mesophyll cell (grey) with chloroplasts (green) (b), wheat bundle sheath cell with chloroplasts (c), chickpea mesophyll cells with chloroplasts (e, f), spongy chickpea mesophyll cell (h), chickpea palisade cell (i), a random wheat chloroplast (j) and a random chickpea chloroplast (k). Segmented 2D micrographs of a wheat mesophyll cell with chloroplasts (l) and a chickpea mesophyll cell (m). Panels (l) and (m) provide examples of the segmentation process.

to both microscopists and plant biologists. After the conferences, I had two goals: publish our findings and submit my thesis. The hardest part of writing up my work was finding a direction – there was lots of ways we could take the research. The more I read and researched during my PhD it became clear that the accepted textbook interpretation of leaf anatomy, where cells and organelles are treated like cylinder and sphere cartoons, needed to be addressed. To test the accuracy of

estimating anatomical properties from 2D images, I took random slices from the SBF-SEM image stacks and calculated the surface area and volume and compared this to the actual 3D values. Alongside amazing colleagues, our Sydney University 3D leaf group published “*Cell and chloroplast anatomical features are poorly estimated from 2D cross-sections*” as a methods paper in New Phytologist. My favourite PhD moment was seeing a 3D chickpea mesophyll cell we had reconstructed make



Our virtual reality pop up at the Camden show for visiting primary schools.

the cover of the journal!

To complement the research, Margaret and I also developed a virtual reality application for Oculus Rift and smart phones. The applications had the users “teleport” or “fly-through” authentic leaf structures. It was a great little side project and sparked a passion for science communication and outreach. Over the course of the research,

we ran events ranging from high school visits, setting up a virtual reality tent at the Camden show and using virtual reality to compliment lecture material.

After completing my PhD, I took up a Post Doc with Margaret. We have a back catalogue of

If anything sparked your interest drop me a line at
richardwilliamharwood@gmail.com



James Ruse high school students exploring an authentic wheat mesophyll cell. untouched SBF-SEM datasets for which I am developing automated techniques to increase the speed we can extract anatomical information.

Throughout my PhD I was always super interested in machine learning and it has been a great experience having the time to explore its capacity to segment leaf microscopy data.

What I’m most excited for is to see 3D models of carbon, water and light transport run on different authentic leaf anatomies, theoretically there is scope to develop a “virtual leaf” where experiments that were previously lab based could be computational.



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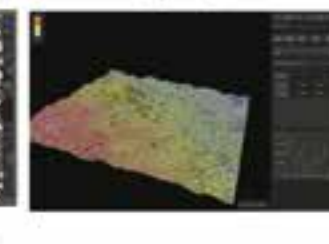
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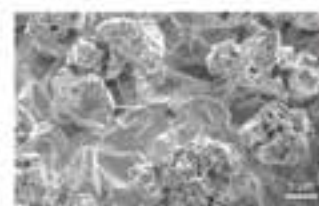
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PRESS RELEASE



CHRIS O'BRIEN LIFEHOUSE STRENGTHENS CANCER FIGHTING RESEARCH WITH THEIR NEW PHENOM XL G2 DESKTOP SEM

WE'RE PLEASED TO ANNOUNCE THAT THE new second-generation Phenom XL Desktop Scanning Electron Microscope (SEM) is installed in VectorLAB at Chris O'Brien Lifehouse (COBL). The Phenom XL desktop SEM is being used to unlock key insights and facilitate the rapid, high-resolution analysis of microstructures of 3D printed biomaterials, to shorten the path between discovery and new cancer treatments.

VECTORLAB AT CHRIS O'BRIEN LIFEHOUSE

Formed over a decade ago by A/Prof Nataalka Suchowerska and Professor David McKenzie, VectorLAB is a collaborative research space that brings together scientists from Chris O'Brien Lifehouse comprehensive cancer hospital and The University of Sydney School of Physics to solve some of the most urgent problems in cancer.

Researchers from the disciplines of medicine, physics, biology and chemistry work together to translate advances in science and technology to the practice of medicine. Chris O'Brien Lifehouse is the largest cancer clinical trial centre in New South Wales, giving cancer patients access to some of the world's newest lifesaving drugs and breakthroughs. Research and trials are carried



Phenom XL arrival at COBL and training at ATA Scientific.

out by the same clinicians who treat patients, shortening the path between discovery and new treatments.

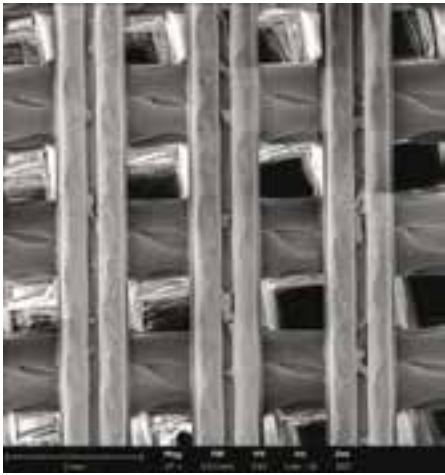
RESEARCH AT VECTORLAB

VectorLAB is engaged in a broad range of research projects, with the common focus of translating emerging technologies and understanding in science to medicine for the benefit of the patient. Typically, when cancer patients require surgery that involves removal of sections of bone to treat their cancer, the bone will be replaced either with bone from another part of the body or a



titanium implant. The VectorLAB team is working on an exciting project to find a way to use 3D printed polymer implants that when implanted into the body, integrate with the patient's bone. The Phenom XL is being used extensively and is facilitating the development of high-performance polymer implants. By meeting the need for high-speed and high-resolution imaging in addition to versatility and ease of use, the Phenom XL allows SEM analysis to be brought inhouse, shortening development cycles. Rapid, high quality images of 3D printed polymer implants generated using the Phenom XL will help expedite research and

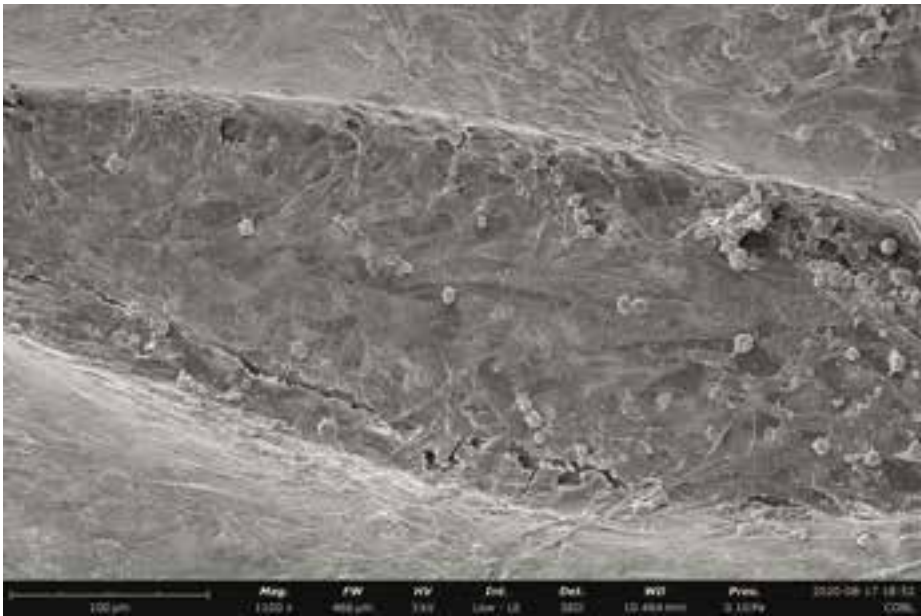
“When patient implants fail, we sometimes don't know why. The images provided by the Phenom will enable us to build bone replacement implants that fit the patient needs better and last longer



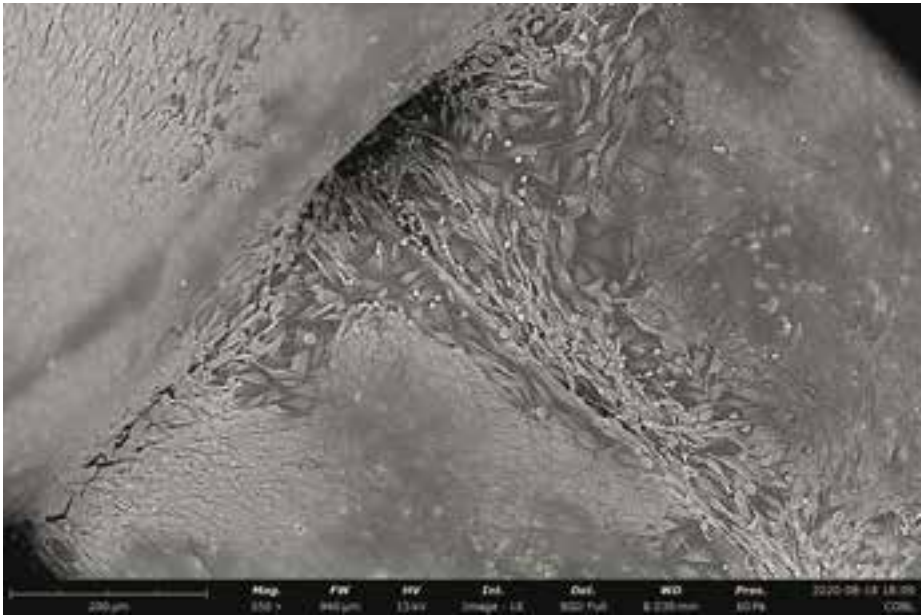
Wide field view examining the overall structure of the 3D printed scaffold. Image taken using the Phenom XL G2 desktop SEM.

development of new implants that are custom built and optimised for individual patients. Future projects in store for the Phenom XL SEM include:

- Imaging of surface features and fine structures of 3D printed objects, mainly orthopaedic implants
- Analysis of surface properties



Secondary electron image of gold coated bone cells on the scaffold showing the surface detail.



Low vacuum backscatter image of osteoblasts [bone cells] growing on the surface of the 3D printed scaffold. Images taken using the Phenom XL G2 desktop SEM.

such as porosity and roughness of 3D printed implants

- Identification of contamination of 3D printing materials and other biomaterials
- Imaging of interaction of human cells with 3D

printed implants, specifically cell adhesion, spreading, colonisation and mineralisation, indicating differentiation of the cells

- Quantification of cell mineralisation on the implant

Customer's perspective

"The intuitive and simple yet sophisticated user interface makes the Phenom a pleasure to use"

We first encountered the Phenom Scanning Electron Microscope at The University of Sydney where it is used for engineering applications. We found the compactness as a desktop unit and the operation speed of the Phenom XL made it a good tool to answer our questions in the medical research environment. The high-resolution images enabled us to visualise our biological samples without special sample preparation, providing evidence on how to give patients the best implant outcomes.

"The Phenom provides answers to questions that were holding us back"

Our experience with the system has been positive. The intuitive and simple yet sophisticated user interface has convinced us that we will make use of the Phenom beyond the immediate project. The Phenom XL provides a large sample stage [10 cm²], which enables us to analyse large samples as well as side by side analysis of replicates in biological experiments.

"Effortless SEM analysis to do more research"

Mineralisation is the process by which pre-osteoblastic cells become solid bone. With the Phenom, we can now easily identify mineralised regions on our 3D printed implants and quantify their atomic composition by Energy Dispersive X-Ray (EDX) Analysis. We can essentially follow the cells' colonisation of the 3D printed structures and identify surface features that benefit the cells' mineralisation behaviour. We find this approach to be more sensitive than chemical methods traditionally used to quantify mineralisation.

UNIQUE FEATURES OF THE NEW PHENOM XL G2 DESKTOP SEM

The next generation Thermo Scientific Phenom XL G2 Desktop SEM is a robust, versatile, and effortless desktop scanning electron microscope designed to expand the capabilities of research facilities.

Its ease-of-use, rapid sample preparation and handling produce unparalleled time to data.

Users can obtain high-quality images in just 40 seconds—three times faster than other desktop SEM systems.

Phenom XL offers an improved resolution of 10 nanometres, enabling even more resolving power and the ability to explore large samples of up to 100 by 100 millimetres.

When compared to the more common tungsten filament electron sources, its Cerium hexaboride (CeB₆) electron source is longer lasting with higher brightness.

In addition to fast, high-resolution imaging, the Phenom XL G2 has an integrated energy dispersive X-ray (EDS) detector for elemental analysis. A simple click on the spot of interest will provide a list of elements present using live energy-dispersive X-ray (EDS) analysis.

The all-new 24-inch diagonal user interface combines what were once separate screens for images and analyses into a single full-screen image providing faster and convenient access to information needed.

The Phenom XL G2 is an intuitive desktop SEM that requires little training and no expert oversight, making it the perfect solution for research groups that want to extend electron microscopy to a greater number of staff and students.

VectorLAB at Chris O'Brien Lifehouse formally acknowledges the following collaborators and funding groups that assisted to make this possible.

- Australian Government – Funding for the Sarcoma Surgical Research Centre and for the construction of the new VectorLAB PC2 Laboratory at Chris O'Brien Lifehouse.
- The Ian Potter Foundation – Funding for the Phenom XL.

Note: The Phenom XL SEM is currently in use at Chris O'Brien Lifehouse and will be moved to the new expanded laboratory space upon completion which has been slightly delayed due to the current flux of COVID-19 government restrictions imposed. Be sure to read our article in the next issue where we will include a follow-up and some exciting new developments.

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PRESS RELEASE

JOURNEY THROUGH THE BRAIN – MAKE OPAQUE TISSUE TRANSPARENT WITH X-CLARITY

"SEEING IS BELIEVING" IS A COMMON rule of thumb for many fields and is the most commonly utilised method for studying, proving, and "believing" experimental results. It's particularly useful when studying brain tissue as imaging helps us understand the connectivity and dynamics of neuronal networks and brings us closer to system-level understanding of physiology and disease in complex mammalian systems.

However, the complexity of brain tissue and natural opaqueness can reduce image resolution. A variety of molecules such as water, lipids, and proteins interact with light causing it to scatter, limiting the amount of light transmitted essential for microscopy.

One way to improve resolution, is to reduce the scattering by removing water and lipids from tissue. Early tissue clearing methods employed organic solvents to clear large organs, several of which were highly toxic and damaged delicate neural tissues through shrinkage and dehydration, which quenched most fluorescent proteins.

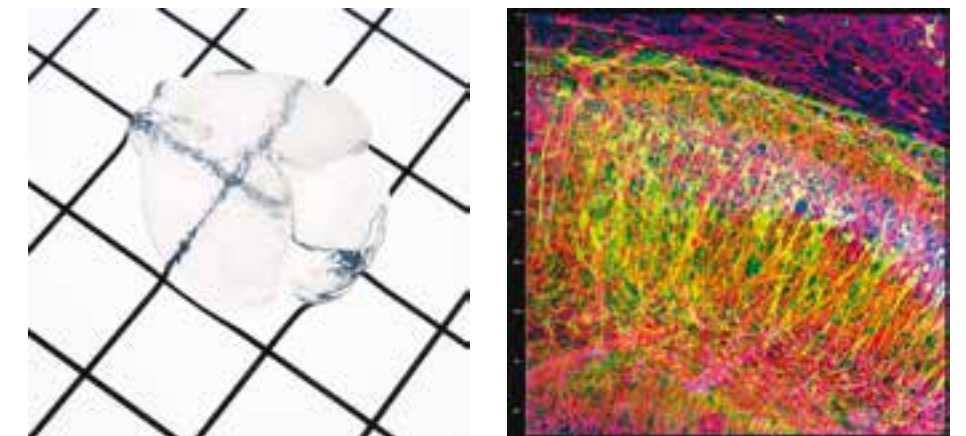
The growing need for high resolution 3D imaging of larger, thicker samples without sectioning has led to the development of the X-CLARITY advanced tissue clearing method.

The difference is clear with X-CLARITY™ systems and reagents

The X-CLARITY is an all-in-one system that optimises the tissue



Secondary electron image of gold coated bone cells on the scaffold showing the surface detail.



Ultrafast clearing made simple to accelerate whole tissue 3D imaging. X-CLARITY allows users to clear a whole mouse brain in just 6 hours while also maintaining endogenous fluorescent protein signals. Thy-1-YFP mouse brain cleared with X-CLARITY, labelled with anti-Collagen IV and TO-PRO-3. Long-term preservation of the Thy1-YFP signal in tissues cleared with the X-CLARITY™ systems and reagents is made possible.

clearing process. It transforms intact biological tissues into a nanoporous hydrogel-tissue hybrid, preserving anatomical structures, proteins and nucleic acids in preparation for high-resolution intact tissue imaging.

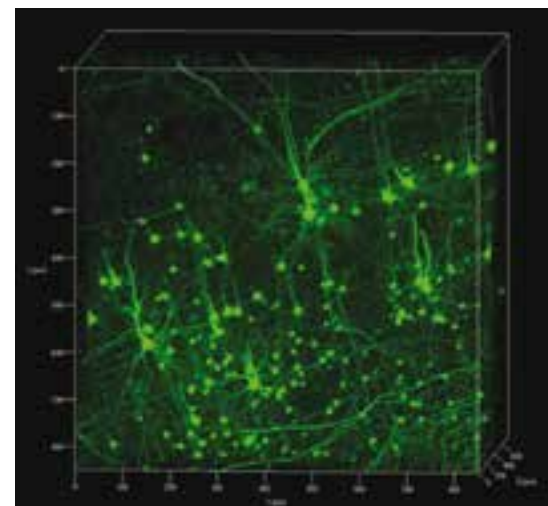
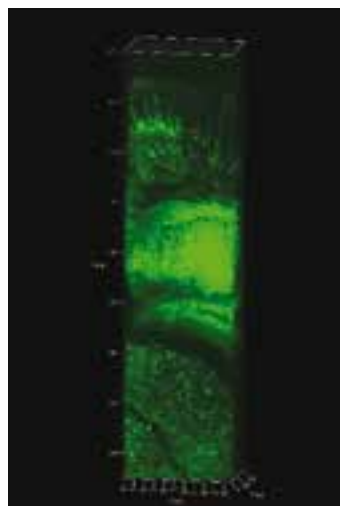
The X-CLARITY™ system with ready-to-use reagents offers simple, rapid and reproducible tissue clearing that is aqueous based. Building on the CLARITY (Clear Lipid-exchanged Acrylamide-hybridized Rigid

Imaging / Immunostaining /in situ-hybridization-compatible Tissue hYdrogel) method, originally developed at Stanford University, X-CLARITY simplifies the electrophoresis technique and shortens the processing time to allow clearing of intact whole tissues and organs from the soft brain to the hard bone.

Using X-CLARITY, preserved tissues are embedded in a hydrogel matrix, which provides an infrastructure to support the form and structure of the brain or other organs. Homogeneous extraction of lipids is made possible in the electrophoretic tissue clearing (ETC) chamber using platinum-plated electrodes and built-in cooling system for temperature control.

This creates a more stable and optically transparent tissue-hydrogel hybrid that is chemically accessible for multiple rounds of antibody labelling and 3D imaging. X-CLARITY DeepLabelTM Antibody Staining Kit can rapidly and efficiently penetrate thick, protein-dense tissues for site-specific binding while the Mounting Solution is used to enhance optical clarity.

This is a high-quality refractive index matching solution that minimises photobleaching and preserves fluorescence signals for vibrant fluorescence imaging.



Left: Thy1-YFP signal immediately after clearing. Right: Thy1-YFP signal one month after clearing.

RECENT PUBLICATIONS WHERE X-CLARITY HAS BEEN CITED

- [1] Neurovascular and immune mechanisms that regulate postoperative delirium superimposed on dementia. 2020. Wang P, Velagapudi R, Kong C, Rodriguez RM, Wetsel WC, Yang T, Berger M, Gelbard HA, Colton CA, Terrando N. *Alzheimer's & Dementia: The Journal of the Alzheimer's Association* 16(5):734-749.
- [2] Presynaptic Boutons That Contain Mitochondria Are More Stable. 2020. Lees RM, Johnson JD, Ashby MC. *Frontiers in Synaptic Neuroscience* 11:13.
- [3] Transparent tumor

microenvironment: Are liposomal nanoparticles sufficient for drug delivery to hypoxic regions and clonogenic cells? 2020. Samson AAS, Hong S, Purushothaman B, Lee J, Song JM. *Applied Materials Today* V19 : 100561.

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PRESS RELEASE



CELENA-X: EVERYTHING YOU NEED

WHEN YOU THINK OF

MICROSCOPY, a few names come to mind, generally massive international corporates steeped in history almost stretching back to Antonie van Leeuwenhoek! And secretly you ponder if you are paying a premium for this; maybe you are!

It is an audacious move to challenge these giants and carve a niche in the microscopy market. Let's breakdown and explore the desirable attributes of a microscope that enable it to tick all the boxes.

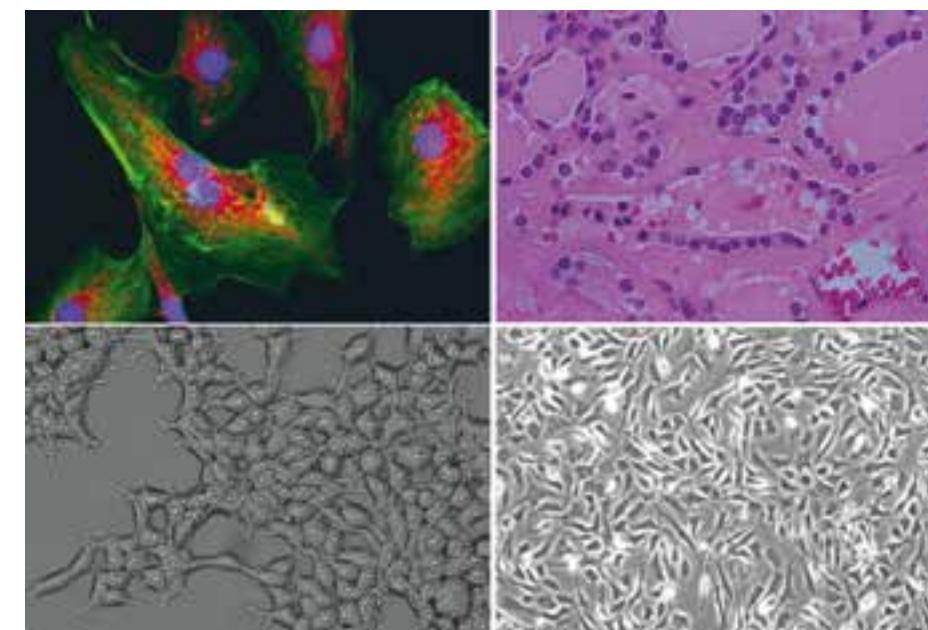
BUCKET LIST OF IMAGING TOOLS FOR CELL BIOLOGISTS

Brightfield, if coupled to a colour camera, can provide clearer Haematoxylin and Eosin (H&E) imaging, whilst Phase Contrast is a technique developed to enhance resolution.

There is however a limit to the signal vs noise ratio and frequently the lack of resolution is limiting. The addition of fluorescence channels expands the ability to explore molecular specificity by enhancing the signal to noise ratio but care needs to be taken to avoid photobleaching.

When live-cell imaging is performed over a few days, photobleaching becomes more apparent. Strategies such as laser autofocus, which drastically speeds up focusing compared to image-based focus, can be implemented to curb these effects.

As probes go deeper and



Four imaging modes: Fluorescence imaging in four channels, brightfield, colour brightfield, and phase contrast imaging.

research demands increase, the inclusion of Z-stacking is becoming standard, not just for a few wells, but over 384 wells without losing focus when creating a full assay approach.

WHAT ARE THE SPECIFICATIONS THAT MAKE AN IMPACT?

Objective lenses - This is where the old guard can help - Olympus lenses are great quality and have quite a range you can hand-pick to match the system and application, giving flexibility to image from say 4x to 100x.

Filter cubes - High quality can make a world of difference. A flexible system should have a selection of filter cubes to enable

the use of fluorescent probes. As the white light source has a spectrum of colours, the filter cube yields a defined wavelength to excite the fluorophore of interest without interference from other wavelengths. This is why fluorescence produces such high contrast images compared to brightfield.

Detection Sensors - Generally these have an optimal size before you start to experience impacts such as vignetting. More is not always better- sometimes it is a balance of resolution, noise and file size where the optimisation of detector architecture becomes seriously important. Simply adding more detector pixels may appear at first glance to increase

resolution, however, the surface area available can limit light, which can be lost in the surrounding noise. Extra pixels also impact heavily on file size and create data storage issues.

Colour cameras – Produce vibrant images for particular applications, as with other detectors, there are positives and negatives to their use. A H&E stained slide would benefit greatly, whereas a fluorescent image would be diminished. Having both colour and monochrome cameras installed that are user selectable would be ideal.

CO₂ incubation and/or hypoxia conditions – is a general requirement for live-cell experiments. Making an incubator is not a simple task, especially if you wish to ensure an even distribution of CO₂ across your wells to have identical conditions for all the cells. Placing a system in an incubator is detrimental to the instrument and health of the operator as mould growth inside is unavoidable – this doesn't bode well for delicate electronics. Also, it ties up an incubator!

Post processing – of the data you acquire shouldn't require you to have a pilot licence. It should



be as easy as loading the images, defining the analysis you want and pressing go! You should be able to easily store the methods for future use to ensure continuity of analysis across the project. Remote analysis is important to free up the microscope for acquisition, plus you can easily do this at your desk or home.

PRICED FOR ACCESS

Given the Celena-X can do all this and more, there this another facet I haven't touched on as yet, the super competitive price set to disrupt this market. The desirable

features above are often out of reach for individual labs, relegating the researcher to join the queue at the central facility costing time and convenience. Perhaps it is time to explore if indeed the Celena-X is Everything you need.

For more information please contact Peter Davis:
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PRESS RELEASE

REVEAL COMPLEX INDIVIDUAL CELL BEHAVIOURS AND UNLOCK UNIQUE INSIGHTS IN EVERY ASSAY

LIVECYTE - NOT ANOTHER MICROSCOPE!

Live-cell time-lapse microscopy is an established and powerful technique for the study of mammalian cell biology in vitro. Multiple microscopy technologies exist, each presenting their own set of benefits and limitations.

Individual cell segmentation and tracking using traditional label-free methods such as brightfield or phase contrast is challenging due to a lack of inherent imaging contrast.

Fluorescent labels enhance cell contrast but also have the potential

to alter normal cell function and induce toxicity. The high intensity light required to excite fluorophores can also alter cell behaviour and induce cell death largely due to photodamage.

The consequences of this are the subtle changes in cell morphology, motility and proliferation that may have unforeseeable effects on experimental outcomes that are often overlooked.

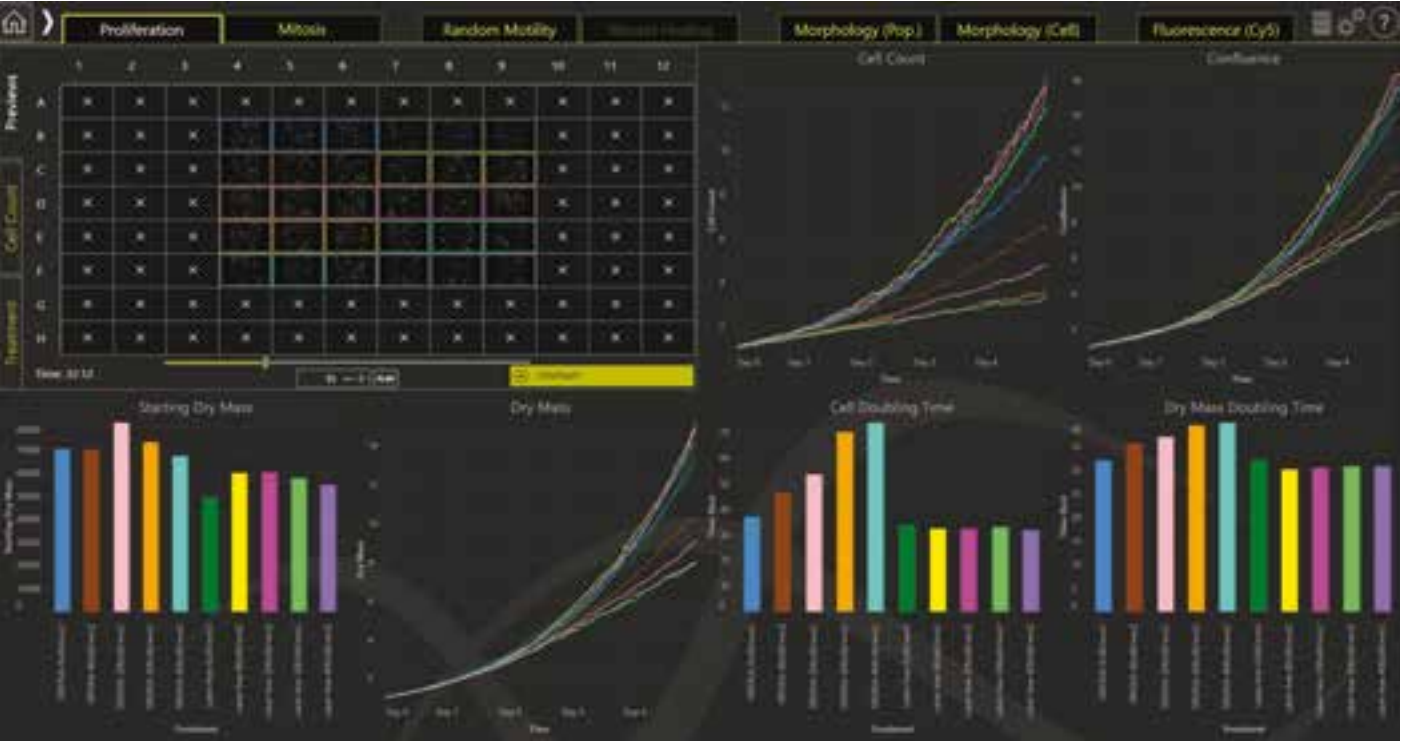
WHY AREN'T CONVENTIONAL SYSTEMS DELIVERING?

The loss of true data is increasingly normalised, subtle

phenotypical changes are lost due to deficient modalities forcing constant compromises to gain contrast.

Throughput often trumps detail! In an attempt to create a stable temperature and humidity environment, some microscopes are subjected to a life in an incubator, leaving them prone to mould and degradation of electronic components leading to unanticipated repair costs.

Microscopy seems to have moved from an investigatory tool to a mass screening machine. Remember - the devil is in the detail!



SO, HOW DO WE DO THIS BETTER?

Ideally, live cell imaging needs to identify and track individual cells for prolonged periods without the need for perturbing labels and provide high contrast images under low levels of light intensity, to preserve natural behaviours and allow recovery of cells for subsequent experimentation or downstream analyses.

The ability to segment and track individual cells and their generational lineages is paramount for accurate quantification of cell behaviour.

A continuous, large field of view with no loss of resolution or focus that permits even highly motile cells to be tracked during time-lapse imaging can prevent potentially important cells from being lost or overlooked.

Information-rich and reliable data is key where each experiment automatically yields a plethora of phenotypic parameters such as cell thickness, volume and dry mass in addition to kinetic behaviour characterised by cell speed, displacement and confinement ratio.

Imaging systems should be easy to use, require no calibration, no dedicated consumables and have no hidden costs.

PHASEFOCUS LIVECYTE DELIVERS ALL OF THIS!

Phasefocus Livecyte generates high-contrast, fluorescent-like images, using low powered

illumination (4-7 μ W/mm²), in which cells appear as bright objects on a dark background. The enhanced contrast in combination with phase retrieval data increases the robustness of single cell segmentation and tracking algorithms without the need for dyes or probes. This form of Quantitative Phase Imaging (QPI) – Ptychography is an emerging imaging technique that retrieves phase-delay of light passing through a cell. Livecyte can provide you with data not available with any other instrument.

HOW CAN YOU EXTRACT MORE KNOWLEDGE FROM YOUR ASSAYS?

Livecyte can extract the changes in morphology, motion and dry mass of each cell over time. This leads to a more complete characterisation of cell phenotypic properties. Tracking and analysis of individual cells, along with population metrics, to monitor cell speed and directionality of migration together with cell proliferation can allow greater insights into biological processes. Livecyte offers the versatility to measure and monitor sensitive cell types such as primary cells, patient derived cells and stem cells. These types of cells are much closer to their natural origins compared to immortalised cell lines, providing a more realistic account of cell behaviour in response to treatment conditions. Livecyte can also perform correlative fluorescence and brightfield imaging.

DRY MASS – A CLASS ABOVE CONFLUENCE

You know from your cultures that cells spread out, ball up, grow without dividing and their division is not always symmetrical. Given confluence simply measures the change in plate coverage by cells, relying on this rudimentary metric alone clearly results in unacceptable misleading outcomes. Dry mass is the summed mass of all cellular components excluding water. As such, the dry mass measurement is an accurate measure of cell size; accounting for the extent of biosynthetic and degradative processes in addition to uptake and expulsion material by the cell.

ACHIEVE MORE FROM ONE EXPERIMENT.

Livecyte enables a vast array of metrics to be calculated and combined to perform a number of applications such as true proliferation, advanced scratch wound, cell motility, mitotic time, morphology. Within each dashboard application there are a wealth of outputs. Imagine this kind of depth of analysis for every dashboard, for every well, for every cell, for every experiment.

Only one thing to do!

Contact us at ATA Scientific and discover more:
www.atascientific.com.au



OPERANDO FUEL CELL CATALYST EXPERIMENT PUSHES THE RESOLUTION BARRIERS OF LIQUID-CELL TEM

FUEL CELLS ARE IN THE GREEN energy spotlight, especially for transportation vehicles, because unlike batteries, they can produce electricity without the need for recharging and are twice as efficient in converting fuel to electricity with no harmful emissions. However, fuel cells have costly catalyst material within, typically made up of platinum, and understanding the degradation mechanisms of the catalyst material is one way to learn how to synthesize the material to prolong its lifetime. Catalyst particles are nano-sized, ranging anywhere from 1-20nm in diameter, making transmission electron microscopy a critical technique in catalyst characterization.

There are several pathways for catalyst degradation, including particle detachment from the support, coalescence, particle dissolution, particle growth, and Ostwald ripening to name a few.

In this article, researchers are replicating their benchtop studies on a commercial catalyst

material Tanaka-TEC10V50E, used in proton exchange membrane fuel cells (PEMFCs), by using the Poseidon Select Liquid Cell for TEM (LC-TEM) with the integrated electrochemistry package. Here, they can perform typical benchtop cyclic voltammogram studies within the column of a TEM so the pathway from pristine to degraded catalyst can be precisely documented. Furthermore, spatial resolution in LC-TEM has always been a challenge due to beam scatter in liquid. Here, the researchers were able to push the resolution below 1 nm to resolve these 3 nm catalyst particles.

In Figure 2, the researchers performed some baseline electrochemical tests within the Poseidon Select liquid cell to ensure proper deposition of the sample onto the glassy carbon working electrode and an overall comparable environment as compared to bulk scale testing. Differences due to the size of the Poseidon Select cell as compared to the bulk scale

In this article, researchers are replicating their benchtop studies on a commercial catalyst material Tanaka-TEC10V50E, used in proton exchange membrane fuel cells (PEMFCs), by using the Poseidon Select Liquid Cell for TEM (LC-TEM) with the integrated electrochemistry package

electrochemical cell are causes for some differences in the data, but the miniaturization of an electrochemical cell and its affects to the generated data is a well-

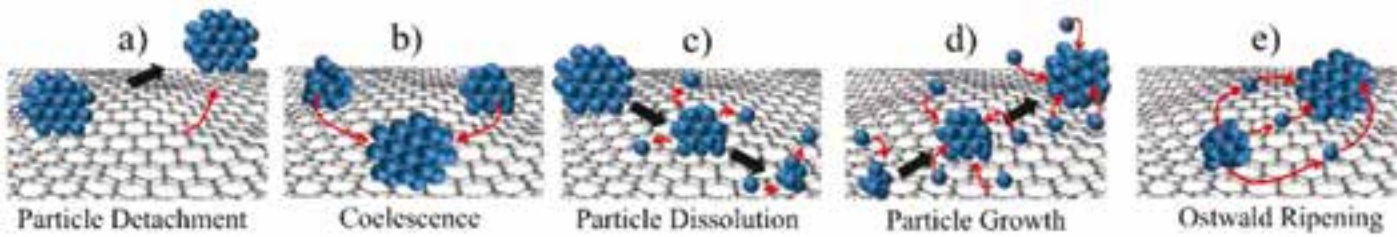


Figure 1: Different potential catalyst degradation pathways.

Cite: Impagnatiello et al., "Degradation Mechanisms of Supported Pt Nanocatalysts in Proton Exchange Membrane Fuel Cells: An Operando Study through Liquid Cell Transmission Electron Microscopy," ACS Appl. Energy Mater, (2020) 3, 3, 2360-2361. DOI: 10.1021/acsaem.9b02000

documented phenomenon found in many electrochemical textbooks. In addition, tests to understand the effects of the electron beam, if any, were performed. Here, the beam had negligible effects on the electrochemical signal.

The micrographs in Figure 3 show the evolution of individual platinum nanoparticles on a carbon support in two different regions of the viewing area (zone 1 and zone 2) for an increasing number of CVs. The main assumption is that the electrochemical active surface area (ECSA) is directly coupled to the particle size and distribution of the platinum catalysts and that their change in size is the driving mechanism of the degradation of the fuel cell.

Statistical analyses performed during the experiment allows the change in particle size to be summarized as show in Figure 4. The electrochemical aging process modifies the size distribution of the supported platinum nanoparticles such that three trends can be pinpointed: dissolution of the smaller nanoparticles, shift of the peak of the distribution toward the larger sizes, and growth of the tail in the distribution profile. This new insight can help guide synthetic chemists in developing catalyst material that is more robust to these processes, enabling a longer catalyst lifetime and more robust overall product.

The Protochips Poseidon Select Liquid Cell TEM system with the integrated electrochemistry package enabled researchers to replicate their bulk scale benchtop experiments within the TEM so the electrochemical aging process could be observed directly. Poseidon Select offers relevant electrode materials like glassy carbon, intuitive cell assembly for quick sample prep, and ultra-sensitive hardware and

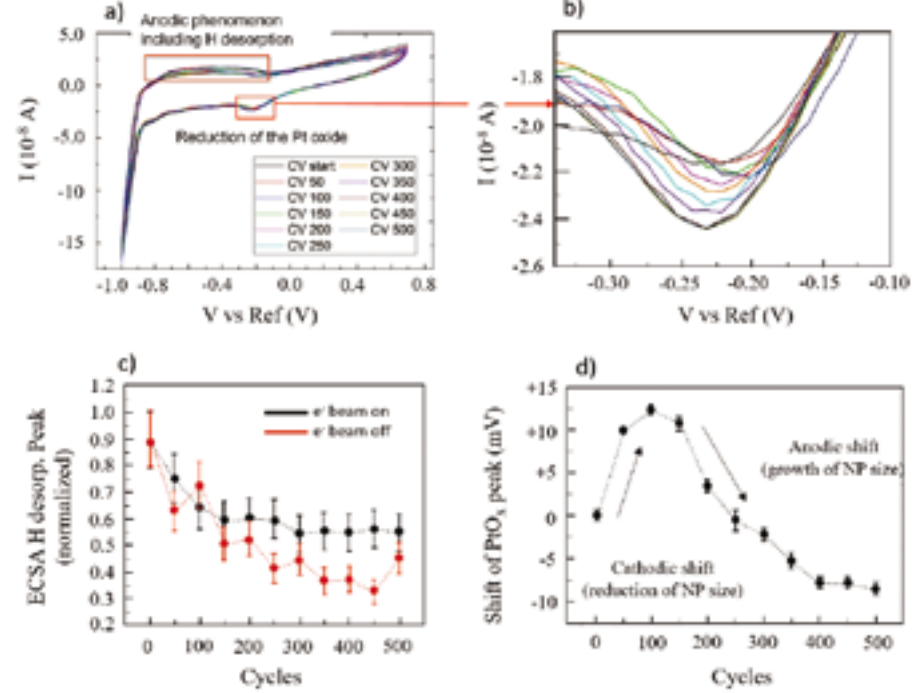


Figure 2: a) Cyclic Voltammetry performed in the presence of the electron beam (beam on) in 0.1M HClO₄ electrolyte up to 500 CVs. The scan rate was 1000 mV/sec. Areas of interest such as the anodic peak including H desorption and the PtO_x reduction peak are indicated by rectangles. Potential range was set here by platinum pseudoreference. b) zoom on PtO_x reduction peak region. c) Plots of the electrochemical active surface area (ECSA) with and without e-beam switching during cycling. d) Shift of the reduction of Pt oxide peak with the number of CVs. Two different regimes are visible : a dissolution regime up to 150 CVs and a growth regime beyond.

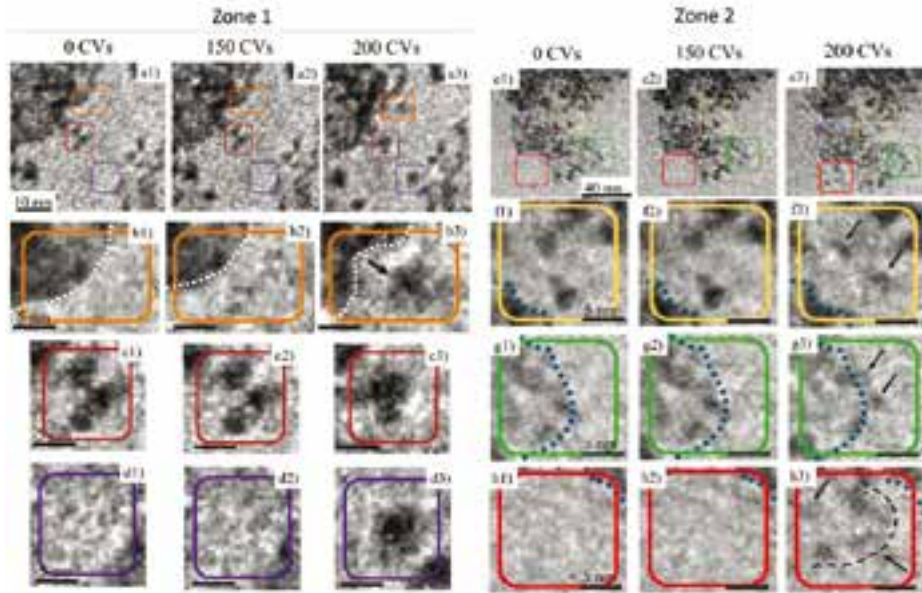


Figure 3: a1-a3) degradation mechanisms in zone 1. b1-b3) detachment (orange squares), c1-c3) coalescence (green squares), and d1- d3) precipitation within the electrolyte (purple squares). e1-e3) degradation mechanisms in zone 2. f1-f3) partial dissolution (yellow squares), g1-g3) migration within the electrolyte (green squares), and h1-h3) precipitation (red squares).

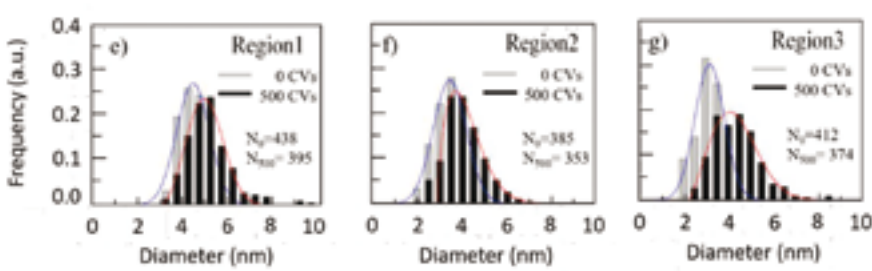


Figure 4: Size distributions of the Pt NPs at 0 CV (gray) and 500 CVs (Black) in region 1, 2, and 3.

MEMS devices for low-noise, quantitative and reproducible results at the nanoscale. Discover new phenomena that can reliably be correlated back to benchtop-scale experiments for new insights that lead to actionable next steps and meaningful, high-impact publications.

Poseidon Select comes with Protochips new AXON Software Platform, which enables 3-D physical and digital sample stabilization that removes the repetitive tasks of repositioning and refocusing throughout an experiment, automatic alignment and embedding of experiment and TEM parameters into the

metadata, and on-demand live review of sample data at any time throughout the experiment.





IN SITU TEM WEBINARS HIGHLIGHT USER EXPERIENCES

These informative webinars highlight how users of DENSsolutions *in situ* transmission electron microscopy (TEM) platforms have used their dynamic, controlled atmosphere capabilities to benefit their research.

Webinars can be reached at www2.axt.com.au/l/462752/2020-08-13/3v39t9

MULTI-SCALE IN SITU OBSERVATION OF CATALYST DYNAMICS UNDER REACTIVE CONDITIONS

In this webinar, Marc highlights the importance of *in situ* liquid phased electron microscopy for catalysis, and shares some of his teams' experience collected over the years.

He shows how they apply a combination of *in situ* TEM and *in situ* scanning electron microscopy (SEM), to study the dynamics of active catalysts under simple redox conditions as well as under industrially relevant reactions, such as methanol oxidation. By bridging the scale from the Å to the mm range and pressures from 10^{-5} to

10^5 Pa, they are able to reveal the dynamic nature of active catalysts and to bridge the materials and pressure gap between simplified model systems and real-world catalysis. It will be shown that simultaneous detection of reaction products by RGA enables correlating structural dynamics with catalytic activity. We observe rate oscillations and oscillatory behaviour that is inherent to the action of a catalyst, which has to break bonds and facilitate the formation of new ones over and over again.



Dr. Marc-Georg Willinger
ETH Zürich, Switzerland

DISCOVER HOW IN SITU TEM ENABLES PROGRESS IN FE-BASED HETEROGENEOUS CATALYSIS RESEARCH

In this presentation, I Xi summarises the advances in *in situ* TEM in heterogeneous catalysis by exemplifying recent progress in Fe-based catalysts.

Fe-based FTS is one of the oldest and most studied industrial catalytic system, but the reaction mechanism and nature of active sites are still under debate. By combining *in-situ* TEM and other techniques, in-depth understanding of the dynamic

chemistry of the iron-carbon-oxygen system was obtained. Meanwhile, the topographic evolution of the catalyst surface was also studied by using the advanced atomically-resolved secondary electron technique, which clearly distinguishes surface features from the bulk feature at atomic scales. It suggests that the electron probing technique will lead to new breakthroughs in the field.



Dr. Xi Liu
Shanghai Jiao Tong
University, China

DIRECT OBSERVATION OF PHARMACEUTICAL CRYSTAL GROWTH VIA LIQUID PHASE ELECTRON MICROSCOPY

Liquid Phase Electron Microscopy (LPEM) enables the visualisation of nanoscale materials suspended in native liquid environments, isolated from the detrimental high-vacuum of the electron microscope.

These *in situ* observations have enabled, insight into nanoparticle growth processes, battery material mechanics and electron beam-influenced decomposition.

This webinar will show the growing influence and impact of LPEM holders in unveiling fundamental insights regarding nanoscale crystallisation events of vital pharmaceutical materials using nucleation and growth of Active Pharmaceutical Ingredients (APIs) such as the Non-Steroidal Anti-Inflammatory Drug (NSAID) flufenamic acid as a case study.



Dr. Jennifer Cookman
University of Limerick
Ireland

4D LIQUID PHASE TEM OF SOFT ORGANIC MATERIALS

Liquid Phase TEM offers tremendous potential in many different fields ranging from soft matter, nano-materials, polymer assemblies, biomaterials, synthetic biology etc.

The liquid nature of the sample presents exciting new opportunities. It is well known that dispersed particles in a liquid undergo Brownian motion involving continuous translational displacement and rotation of the particles.

Such rotation means that each particle dispersed in the liquid

will show several profiles under the TEM disclosing potentially all of its surface. We have exploited this feature for investigating two different soft organic systems in liquid (i) a polymer assembly with a localised asymmetry, and (ii) proteins.

These findings set the foundation for future time-resolved 3D structure reconstruction of fully hydrated soft organic materials in their native environment. Moreover our results open a new avenue for next generation biological *in-situ* TEM.



Dr. Lorena Ruiz-Perez
University College London
UK

IN-SITU BIASING AND HEATING OF SEMICONDUCTING NANOWIRES

In this user webinar Dr. Martien den Hertog will share her experience using the DENSsolutions Lightning system to perform correlated, *in-situ* heating and *in-situ* biasing experiments on semiconducting nanowires.

She presents examples of studies using this approach, where we can distinguish:

1. Ex-situ studies correlating the opto-electrical properties of a single NW with its structural properties such as the crystal structure, composition and

dimensions that are measured by TEM-based characterisation

2. In-situ Joule heating studies on a solid state metal-semiconductor reaction induced by heating where the evolution of the reaction is directly visualised by TEM
3. In-situ electrical biasing experiments where the variation of holographic measurements under bias can be used to analyse the behaviour of Schottky contacts and extract dopant concentrations



Dr. Lorena Ruiz-Perez
University College London
UK

These webinars were organised by DENSsolutions.
For more upcoming webinars please visit www.denssolutions.com



NEW PRODUCT: LIVE CELL IMAGING IN YOUR INCUBATOR WITH LUMANETTE

ETALUMA, DESIGNERS AND MANUFACTURERS OF THE world's most compact and robust inverted microscopes for live cell imaging continue to set the standard with the release of the Lumanette. The Lumanette redefines what is possible for an in situ incubator microscope.

Providing real-time live cell imaging, Lumanette allows multiple position viewing, time lapse movies and live cell assay data to be generated direct from your incubator.

With the ability to be used with your own incubator and computer it provides an extremely cost-efficient pathway to study your cells without the need for expensive microscopes or core facilities.

Using a free software package and USB cable, adding live cell imaging capabilities to your incubator could not be simpler. The Lumanette provides 24 individual 10x imagers for straightforward time lapse experiments in 24 and 6-well microplates as well as flasks and dishes in a system with a footprint not much larger than a standard cell culture plate.

Its' diminutive size means it doesn't take up valuable incubator space, or you can even have multiple Lumanette's in the same incubator.



The thoughtful sealed construction makes it easily sterilisable using common disinfectants, ideal for use in cleanrooms and with infectious diseases.

Simple analysis routines for cell coverage and counting are included and provide real time data and chart visualisation.

Meanwhile, brightfield, darkfield and even digital phase contrast imaging modes are available via the LED light sources.

Live cell imaging with the Lumanette enables the simple automation of routine cell culture applications making it ideal for

drug development, virology, cancer research and in vitro cytotoxicity and biocompatibility essays.

Other key areas where Lumanette will benefit researchers include the analysis cell growth, comparison and analysis of extracellular conditions and migration or scratch assays and Stem cell observations.

"The solid state and robust design make the Lumanette's addition to Etaluma's Lumascope product line a natural for those customers without the need for higher magnification or fluorescence microscopy" said Chris Shumate, CEO of Etaluma.

For more details on the Lumanette, please visit www.axt.com.au/products/lumanette/

INTERVIEW WITH MATTHEW PHILLIPS

AXT and DELMIC recently completed the installation of their SPARC cathodoluminescence and SECOM CLEM systems at University of Technology Sydney (UTS). In this interview, we spoke to Prof. Matthew Phillips who was key in securing the grant to acquire these instruments.

You have a long history working with cathodoluminescence (CL), even having built your own system. What is it about this technique that interests you so much?

The key strength of the CL technique is its capacity to non-destructively measure and image the optical and electrical properties of bulk and nano-structured materials and devices at the nano-scale in three-dimensions. Of particular importance, is the CL technique's ability to study light emitting quantum structures, such as quantum wells, wires and dots.

These quantum structures are typically sandwiched between other semiconductors, which rules out the use of photoluminescence measurements as the capping layer absorbs the laser excitation.

CL measurements, however, are possible by simply increasing the scanning electron microscopy (SEM) electron beam energy so that the injected electrons can traverse the top coating to excite light emission in the embedded quantum structures.

This particular application is why we acquired our first CL system at UTS in 1991.

Additionally, many of the CL peaks in technologically important materials, can be attributed to the different chemical states of dopants and impurities as well as point defects, such as atomic vacancies.

So the CL signal can be used to map their distribution



Prof. Matthew Phillips.

and concentration at high magnification with high sensitivity, which can then correlated to spatial information provided by the SEM or other spatially resolved data physical or structural properties, from, for example, elemental X-ray microanalysis or electron back scatter diffraction (EBSD) results.

What was it about the DELMIC SPARC system that attracted you to it?

Delmic products offer new CL techniques that had not been previously available in commercially available CL systems.

However, the main attraction was the SPARC's outstanding light collection efficiency which is made possible by a high precision alignment system for the parabolic mirror that collects the CL signal. The SPARC also uses high performance low loss light transfer optics to the monochromators and detectors to maximise the



The UTS Team: (L to R) Prof. Matthew Phillips, Prof. Igor Aharonovich, Prof. Milos Toth, Dr. Mark Lockrey and Ms. Katie McBean.

measured CL signal.

The high CL collection efficiency means that the lower SEM accelerating voltages and electron beam currents can be used, which enables higher spatial resolution CL imaging and microanalysis.

The SPARC is capable of several different modes of CL. Which modes in particular are of interest to you?

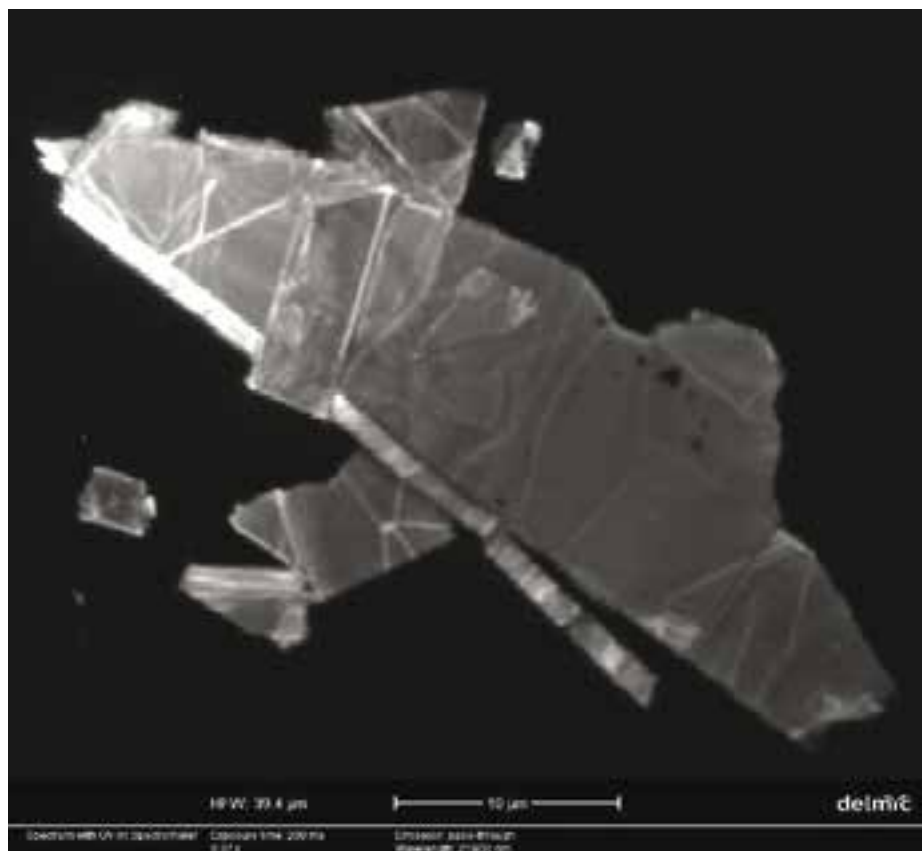
The SPARC system was acquired to expand and enhance our existing CL Facilities at UTS. The new system has 3 high sensitivity CCD cameras that cover the ultra violet (UV), Visible and near-infrared (NIR) spectral regions, measuring light with wavelengths ranging from around 180 to 1600 nm. And has 2 spectrometers, one that facilitates the new CL capabilities and the other high spectral resolution and NIR CL spectroscopy.

I am also very interested in using and exploring the utility of new SPARC CL capabilities, in particular angle-resolved CL, time-resolved CL and polarisation CL.

What experiments will you be able to do with the SPARC that you were not previously able to do and what sorts of materials will you be investigating?

The SPARC CL system will allow CL imaging and spectroscopy studies at high magnification with high CL collection efficiency over broader range of wavelengths from the UV to the NIR.

The new CL capabilities opens



A deep UV (218 nm) image of a h-BN sample at 10 kV and 0.1nA. The HWOE is 39.4μm (courtesy of Dr. Mark Lockrey).

the door for a number of new experiments.

- Angle-resolved CL enables the measurement and mapping of the angle and intensity of the CL emission, which is important in nano-photonics as it enables studies of light-matter interactions at high magnification.
- Time-resolved CL, facilitates measurement and mapping on dopants, defects and impurities based on their CL

emission lifetime instead of their emission energy or colour. The time-resolved CL also allows quantum spectroscopy measurements to detect and study single photon emitters and devices.

- Polarised CL uses to polarisation of the CL emission to image, measure and study light-matter interactions from nano-scale structures and materials.

How many other people are looking at using the SPARC system and what projects and materials are they looking to investigate?

The Delmic/SPARC system was funded by an Australian Research Council Linkage, Infrastructure, Equipment and Facilities grant (LE180100030), with 13 chief investigators from 7 Universities, including UTS, RMIT, QUT, UNSW, USyd, Monash and Wollongong. The Delmic CL system will be used for a large number of projects involving the study of bulk and nano materials used in:

- Optoelectronics
- Plasmonics
- Nanophotonics
- Quantum photonics
- Nano-catalysts
- Sensor development
- Nano bio-photonics
- Bio-imaging as well as
- Energy generation and energy storage technologies

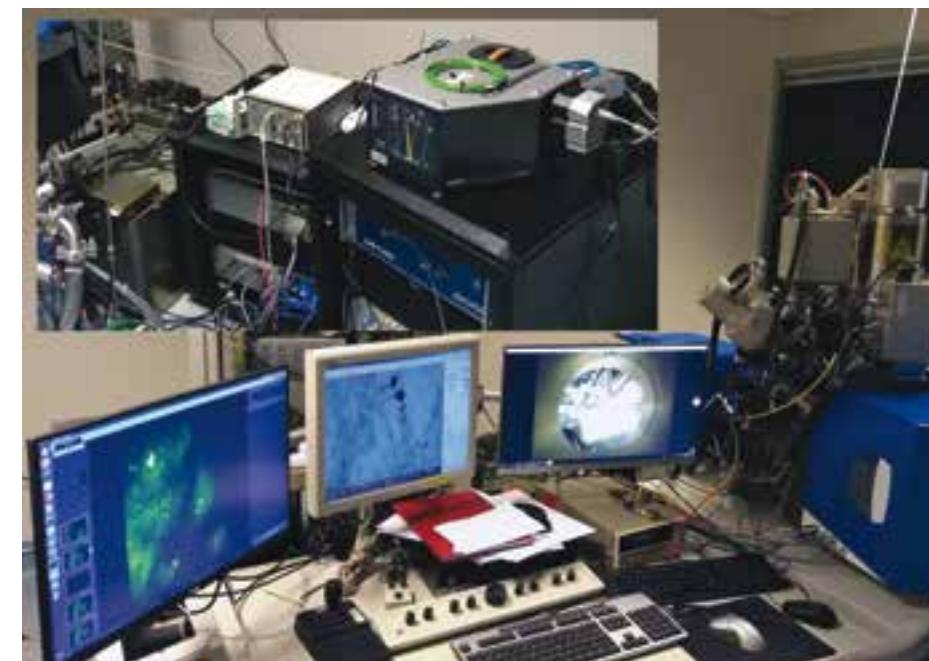
There was an application that the SPARC could theoretically perform. Since your system has been installed you have shown that it can be done. Can you tell us about it?

Photon bunching and anti-bunching spectroscopy measurements are typically conducted using sub-band gap laser excitation.

Consequently, even though the SPARC's time-resolved CL instrumentation was in principle capable of collecting these spectra, there was initially some debate over whether or not the anti-bunching measurement could be performed using electron beam excitation.

So we were very pleased that during the Delmic compliance testing the CL correlation spectroscopy measurement was demonstrated on-site at UTS, using nanodiamond samples that exhibit single photon emission provided by Prof Igor Aharonovich.

You also installed a DELMIC SECOM CLEM system. What



Delmic SPARC and SECOM systems uniquely installed on the same dual beam microscope. The insert shows the external deep UV spectrometer and lab cube time-correlation module.

type of research was that system acquired for?

The Delmic SECOM CLEM platform integrates an optical fluorescence microscope into a SEM using a below sample objective lens with external light sources.

Fluorescence imaging uses functionalised luminescence nanoparticles and dyes to selectively highlight specific regions in biological samples.

The SECOM setup allows the microstructure of the labelled regions to be studied using the SEM at magnifications much higher than what is possible with conventional optical microscopy. We plan to use the SECOM for correlative SEM and fluorescence imaging studies of biological samples.

What features/capabilities of the SECOM system lead you down that path, given its unique configuration?

There were existing plans to build a below sample objective lens setup in a SEM to inject focussed laser light and collect photoluminescence in a SEM for correlative SEM, CL and photoluminescence (PL)

measurements. We have already re-configured our SECOM to enable these measurements.

What projects are you aware of that your researchers will be using it for?

Besides the bio-research applications, the modified SECOM will be used to investigate the optoelectronic properties of nanophotonic and plasmonic nanostructures and emerging 2D materials, up-conversion nanocrystals and metamaterials.

You have installed the SECOM on the same focused ion beam (FIB) as the SPARC. Is this the only installation of its type in the world? And are there any experiments that you have in mind where the two techniques could be used correlatively?

I believe it is. The correlative facility will enable a number of innovative experiments on:

- Multifunctional 2D materials for photonics and energy applications,
- Advanced metamaterials for optical systems, as well as
- Single photon emitters for Quantum Plasmonics and Nanophotonics applications.

MULTIMODAL MATERIALS ANALYSIS FACILITATED BY PLASMA FIB-SEM

Dr. Dean Miller¹, Jiří Dluhoš¹, Dr. Kamran Khajepour² and Dr. Cameron Chai²

¹TESCAN USA and ²AXT PTY LTD

There have been a number of advancements in plasma focused ion beam-scanning electron microscopy (FIB-SEM) in recent years enabling new research into materials that go beyond what was possible with more traditional Gallium FIB-SEMs. Using Xe plasma FIB-SEMs opens up new possibilities for researchers in terms of analysis, sample preparation and nanofabrication.

GALLIUM FIB-SEMS

Ga FIB-SEMs have been key pieces of research infrastructure for many years. However, there are some limitations to the technology, namely:

- Scale/throughput – everyone always wants to do more work in less time, whether this means to process more samples, or analyse larger areas to generate more statistically reliable data
- Gallium poisoning – Ga ions often implant into the sample surface which can compromise analyses, in particular chemical analyses
- Amorphisation and sample damage – another side effect that can potentially alter the structure of the sample and affect analysis via transmission electron microscope (TEM) or atom probe

ADVANTAGES OF XE PLASMA FIB (PFIB)

PFIB overcomes the limitation of Ga FIB without compromise. Due to the small emission surface in Ga FIBs (diameter $\approx 50\text{nm}$), the probe current is limited to around 100nA . Conversely, Xe PFIBs have a large emission surface (diameter $\approx 300\mu\text{m}$) allowing much higher probe current ($>2\mu\text{A}$) which allows much faster milling, while the larger atomic mass/size of the Xe ions significantly reduces the amount of implantation.

Ga FIBs will still have a place,

	Xe Plasma FIB	Ga FIB
Sputtering rate at 30kV on silicon	3.2 atoms/ion $0.4\mu\text{m}^3/\text{nC}$	2.4 atoms/ion $0.28\mu\text{m}^3/\text{nC}$
Maximum probe current	$2\mu\text{A}$	100nA
Virtual source size	$\sim 300\mu\text{m}$	$\sim 50\text{nm}$
Imaging resolution at 30keV	15nm	2.5nm

Table 1: Comparison of Xe plasma and Ga FIB-SEM.

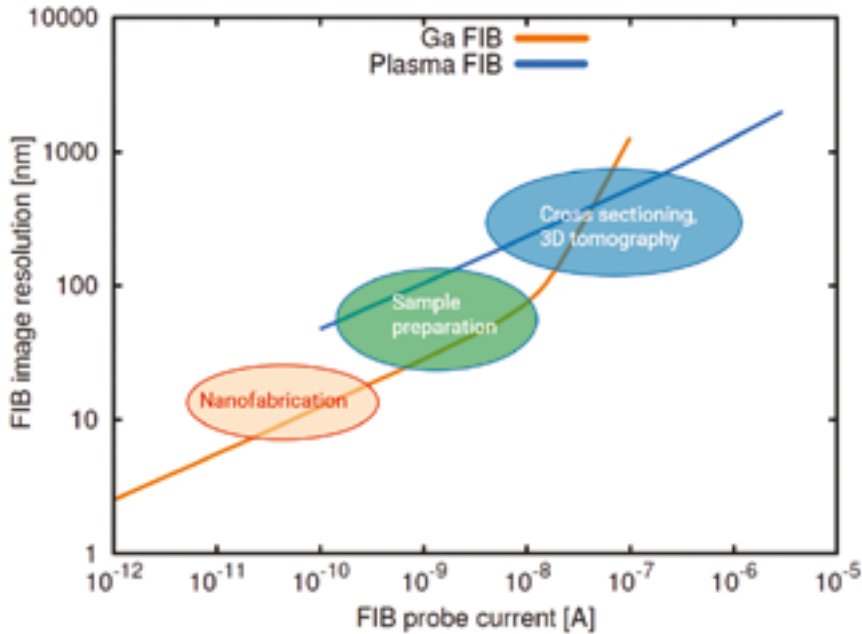


Figure 1: Comparison of Ga-FIB and Plasma-FIB resolution versus probe current.

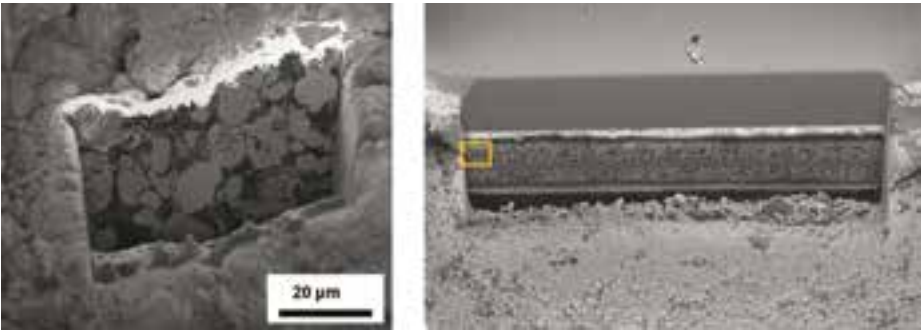


Figure 2: Li-ion battery electrode cross sections prepared using Ga FIB (Left) and Xe plasma FIB (right). Each cross-section was prepared in a similar time. The yellow box indicates the relative size of the Ga FIB cross section.

especially when ultra-high resolution imaging is required. The virtual point source of the Ga FIB allows higher resolution imaging at low FIB probe currents. This benefit does become less evident at higher probe currents.

This makes PFIB ideal for

- Large area volume analysis
- Ga-free processing e.g. micro pillars
- Delicate specimen preparation e.g. atom probe tips

EXTENDING MATERIALS CHARACTERISATION USING A PLASMA FIB-SEM

Many different analytical tools can be integrated into the FIB-SEM. These are aided by the high-resolution imaging capabilities and ability to shape, manipulate and modify the material using the FIB, really transforms the plasma FIB-SEM into a nanoscale laboratory for multi-modal characterisation.

Furthermore, by combining two or more datasets from complimentary analytical techniques, a much more detailed analysis can be achieved, resulting in a far more superior understanding of the material.

CASE STUDY - ANALYSIS OF SOLDER BUMPS USING 3D EDS AND EBSD

In microelectronics, the performance of the solder joints over their lifetime depends on their microstructure, which is dictated by their cooling rate, making cooling rate the determining factor. So, the level of precipitation present, will also influence the composition and grain structure i.e. dendritic structures were undesirable.

Using a large analytical area, made possible with the plasma FIB-SEM, the 3D energy dispersive spectroscopy (EDS) showed minimal amounts of precipitation, while the 3D electron back scatter diffraction (EBSD) revealed a desirable grain structure with no dendritic structures. From these

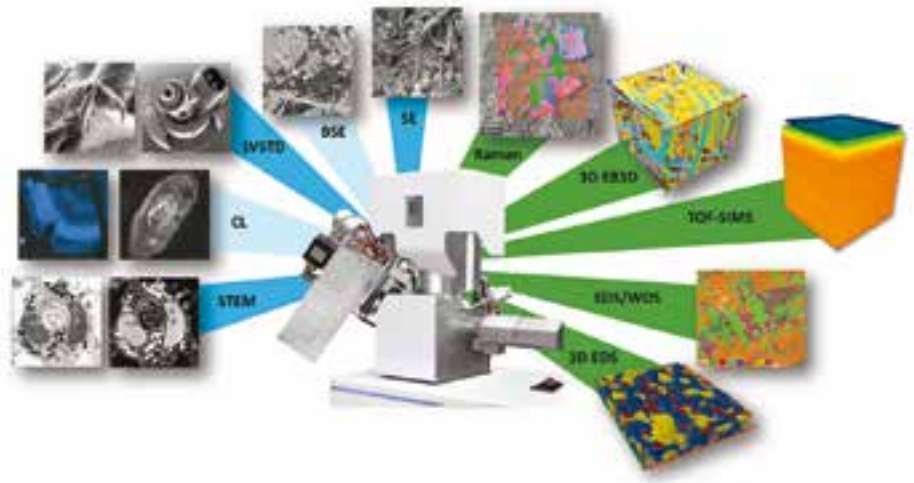


Figure 3: The wide range of analytical modes that can be integrated onto a FIB-SEM to create a multi-modal nanolaboratory.

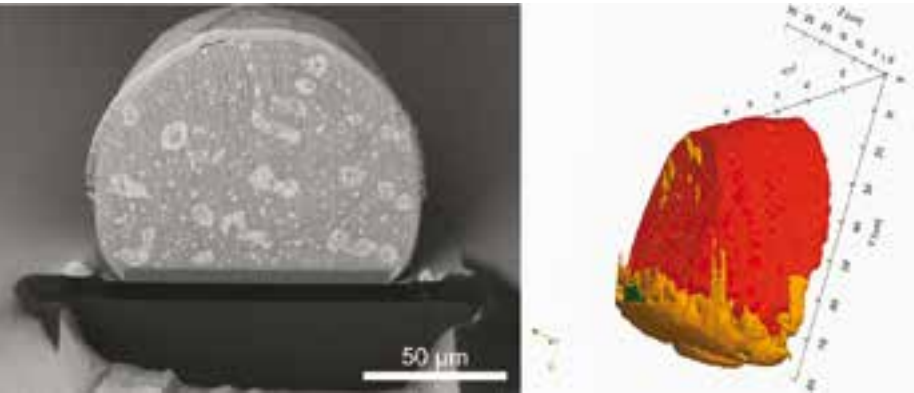


Figure 4: Plasma FIB cross section of a solder bump (left) and a corresponding 3D EDS and EBSD map (right).

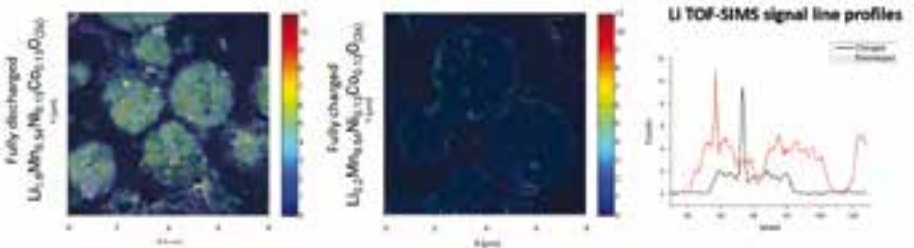


Figure 5: ToF-SIMS maps of the Li-ion battery materials in the fully discharged (left), fully charged (middle) states and corresponding Li ToF-SIMS signal line profiles (right).

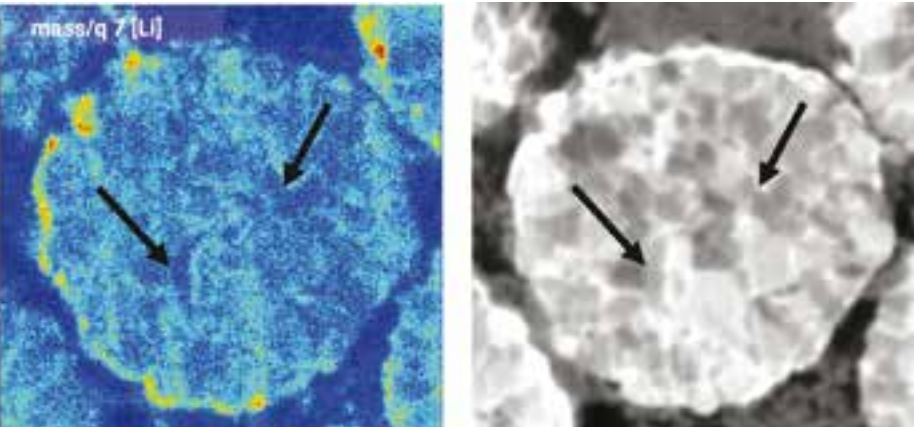


Figure 6: Li mapping of a single particle using ToF-SIMS shows variation of Li content from grain to grain.

datasets, the researchers deduced that a suitable cooling rate was employed resulting in an optimal microstructure.

CASE STUDY - LI ION BATTERIES USING RAMAN AND TIME OF FLIGHT - SECONDARY ION MASS SPECTROMETRY (ToF-SIMS)

There has been a concerted effort in the area of understanding the degradation mechanisms associated with Li-ion batteries in recent years. Understanding these mechanisms is key to optimising their capacity, charge times and lifetimes. To achieve this, sufficient volumes of materials must be analysed, which is an ideal scenario for plasma FIB-SEMs.

Using a plasma FIB-SEM it is possible to generate large area cross sections that can reveal important information about structure. However, the low atomic mass of lithium means that EDS analysis not possible to investigate lithiation of the battery materials.

Looking at the cathode materials using ToF-SIMS enables researchers to map lithium distributions as can be seen in the figure, where light regions indicate areas of high lithium concentration i.e. in the discharged state, where as there is "almost" a complete absence of lithium in the fully charged state. Quantification using linescans has revealed lithium concentrations less than theoretical between the two states indicating incompleteness of the electrochemical reaction, and thus diminished capacity.

Looking at individual particles using ToF-SIMS shows an inhomogeneity in lithium concentration, supporting the theory of fracturing, where neighbouring grains become isolated and unable to fully participate in the charge/discharge process, reducing the battery's capacity. When a large area cross-section prepared using the plasma FIB-SEM was examined using Raman a number of things were revealed. While it was known

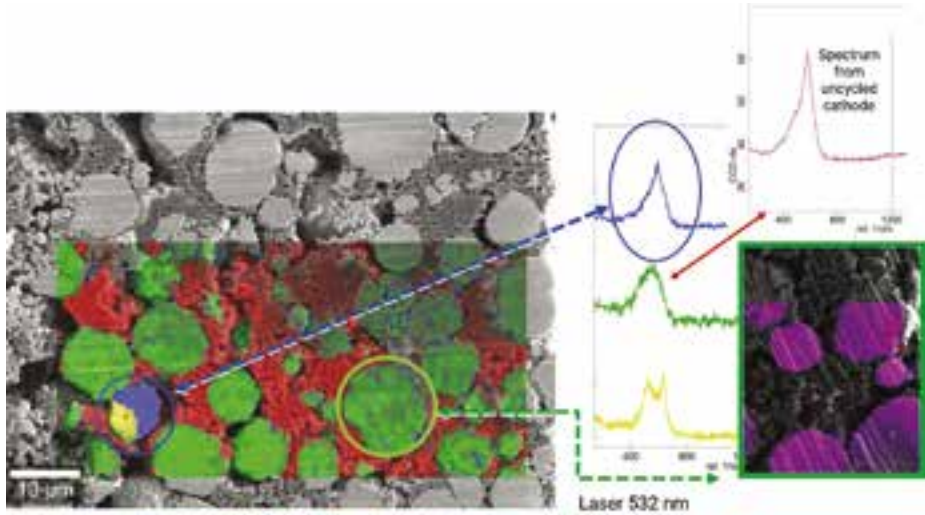


Figure 7: Raman map of the Li-ion battery material showing inhomogeneity.



Figure 8: TESCAN AMBER X Xe Plasma FIB-SEM.

that changes occur after charge cycling, some particles produced different spectra compared to their neighbours.

The similarity to the uncycled material indicates possible isolation from the bonding material and that it has not been cycled as much as other nearby particles. Furthermore, the mottled structure of the cycled particle shows different amount of lithiation throughout a single particle, further supporting the theory that individual particles fragment as a result of cycling.

CONCLUSION

Xe plasma FIBs have a number of key advantages over their

more traditional Ga counterparts. Perhaps the most important of these is the ability to rapidly remove large volumes of material enabling the cross sectioning and 3D analysis of large regions, which can reveal detail that may be missed by analysing smaller regions.

Furthermore, the ability to analyse larger areas ensures more representative data are produced.

The ability to integrate plasma FIB-SEMs like the TESCAN AMBER X with multiple analytical tools such as ToF-SIMS, Raman, EDS, EBSD and others makes these instruments powerful tools for characterising materials, in particular providing large-scale 3D maps.

PRESS RELEASE



RIGAKU ALLIES WITH JEOL TO JOINTLY DEVELOP AN INTEGRATED MICROED PLATFORM

Rigaku and JEOL will unify their core technologies—Rigaku’s high-speed, high-sensitivity photon-counting detector (HPC) and state-of-the-art single crystal software, and JEOL’s transmission electron microscope—to create an integrated Micro Electron Diffraction (MicroED) platform providing one-step structure solutions with electron crystallography.

THE RESULTING MICROED PLATFORM, BASED ON the synergistic collaboration of both companies, will provide a solution for the needs of leading-edge structural science to elucidate three-dimensional molecular structures from single crystals smaller than 100 nm

Rigaku (Akishima, Tokyo, Japan) has entered into an agreement with JEOL (Akishima, Tokyo, Japan), a leading company in electron microscope technologies, for the joint development of a MicroED platform to solve the structures of sub-micron crystals using electron crystallography.

Single crystal X-ray crystallography has long been the primary technique used to determine the 3D molecular structure of inorganic, organic and protein molecules.

Rigaku’s latest HPC detector and advancements in X-ray source brilliance have reduced the minimum measurable crystal

size to the order of a few microns. However, it is often the case that the crystals that researchers can obtain of new materials are smaller than 100 nm. These nanoscale crystals have traditionally been out of the scope of X-ray crystallography.

Recently, electron crystallography, typically called MicroED, has been in the spotlight as a method to address the need to measure increasingly small nanoscale crystals. The strong matter interactions provided by electrons offer the potential to study these smaller samples. Electron crystallography has a long history, but it has not been commonly used because of the severe radiation damage it causes to organic and protein molecules.

The HPC detector addresses this issue with its excellent sensitivity and extremely low noise characteristics, reducing the required exposure to electrons to the level where sample decay

can be ignored. Rigaku has long been at the forefront of advanced analytical X-ray instrumentation and JEOL is a leading company in the field of electron microscopy.

Both companies are market leaders in their respective industries.

The scope of the joint development includes integration of Rigaku’s high-speed, high-sensitivity HPC detector and state-of-the-art CrysAlis^{Pro} structure analysis software platform with JEOL’s high-performance transmission electron microscope technology

The resulting system will provide researchers with a completely integrated solution for performing MicroED experiments. Rigaku and JEOL will synergistically contribute to the scientific research frontier through the introduction of an easy-to-use MicroED platform that greatly reduces the crystalline sample size necessary for 3D structure determination.

The Life of Brian

Stan: I want to have babies...it's every man's right to have babies if he wants them

Reg: But you can't have babies!

Stan: Don't you oppress me!

Reg: I'm not oppressing you, Stan! You haven't got a womb. Where's the foetus going to gestate? You going to keep it in a box?!?



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A NEW CHAPTER IN HIGH-SPEED AFM: MOLECULAR DYNAMICS IN REAL-TIME AT 50FPS

THE NEW *NANORACER* HIGH-SPEED ATOMIC FORCE

Microscope (AFM) system from Bruker/JPK offers an unprecedented imaging speed of 50 frames per second, which sets a new milestone in high-speed scanning capabilities to enable true real-time visualisation of dynamic biological processes using AFM.

Developed in close collaboration with leading experts in the field, the *NanoRacer* also delivers atomic resolution and unmatched user friendliness, and it is expected to provide crucial insights into single-molecule behaviour and an in-depth understanding of dynamic processes in biochemistry, molecular biology, and biomedicine.

The *NanoRacer* system is

designed for use with small cantilevers. It can achieve top speeds of 50 frames/sec in fluid, in a 100nm x 100nm scan range, and with 10k pixels.

Equipped with photothermal cantilever excitation, a new XYZ flexure scanner architecture, and lowest noise positioning sensors in each axis, the *NanoRacer* sets a new benchmark for high-end research AFM capabilities.

Lowest forces and highest resolution, combined with utmost

stability, make it a powerhouse for advanced applications and discoveries on the molecular scale. The new system also incorporates JPK's high-performance Vortis™ 2 controller and intuitive software user interface for superior ease-of-use operation.

The fully automated setup capabilities allow researchers to focus on their experiments, making the *NanoRacer* system perfect for multi-user environments or imaging facilities.

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