

## Australian X-ray Analytical Association

Newsletter Issue 1 2023

### **President's Address**

Dear AXAA members and friends,

This issue, I wanted to reflect on the important role that X-ray and neutron science plays in advancing our understanding of the natural world. The techniques we've developed to harness X-rays and neutrons allow us to study the internal structure and properties of materials at the atomic level, leading to breakthroughs across pretty much every field from materials science, earth science, solid-state physics, and medicine.

As X-ray or neutron scientists, we have a unique opportunity to continue pushing the boundaries of what is possible. We can use our knowledge and expertise to develop new techniques and tools for imaging, scattering, and spectroscopy, improve the sensitivity and resolution of our instruments, and explore new applications for X-rays in fields such as energy storage and renewable energy.

In this issue, Dr Tony Wang provides an introduction to laboratory-based Pair Distribution Function analysis and Dr Gemeng Liang describes the use of advanced synchrotron radiation techniques in the evaluation of lithium-ion batteries.

AXAA seeks to foster collaboration and information exchange within the X-ray community by highlighting recent research activity and opportunities relevant to the field as well as through the organization of seminars and workshops. In the first week of June 2023, we will host a Melbourne networking day at the Australian Synchrotron. Our keynote speakers will be Dr Justin Kimpton (ANSTO) and Dr Niloofar Karimian (CSIRO), and we will have a morning tea sponsored by Dectris. We are currently soliciting student abstracts, if interested please submit a short (<300 word) abstract to ausxray@gmail.com. We hope to see you there, but if you can't make it to Melbourne keep an eye out as we host other events around Australia!

We thank you for your continued support, and may you all have a productive and rewarding winter season.

Jessica Hamilton AXAA President

### AXAA Networking Day – Melbourne

Join us for a day of talks, prizes, and a morning tea sponsored by Dectris at the Australian Synchrotron! This will be an excellent opportunity to hear from others in the X-ray community and check out Australia's favourite particle accelerator.

When: Friday 9th June, 9:00 AM

**Where**: Australian Synchrotron, Clayton VIC **How to attend**: A registration link will be sent from the AXAA mailing list, keep an eye on your inbox!

**Our Keynote Speakers:** 





**Dr Niloofar Karimian** (**CSIRO**) will be speaking on applied X-ray techniques in environmental geochemistry. Dr Justin Kimpton (ANSTO) will provide an update on the Advanced Diffraction Beamlines at the Australian Synchrotron.

#### **Attention Melbourne Students!**

Do you use X-ray or neutron techniques in your work? We'd love to hear from you! Prizes will be on offer at the AXAA student networking day for best talk. **To apply, send an abstract (<300 words) to ausxray@gmail.com by 23rd May** 





## Advanced Synchrotron Radiation Techniques for Lithium-Ion Battery Studies

Gemeng Liang<sup>1</sup>, Jinshuo Zou<sup>1</sup>, Zaiping Guo<sup>1</sup> <sup>1</sup> School of Chemical Engineering, The University of Adelaide

#### Introduction

It is urgent for human society to address the global energy crisis and achieve carbon neutrality within the next few decades, and the rapid adoption of clean energy and the wholesale switch to electric transport will play key roles. Rechargeable batteries not only resolve the intermittent drawback of renewable resources, but have also become the core challenge in the electric vehicle development. Nowadays, lithium-ion batteries (LIBs) dominate the global rechargeable battery market, especially in the fields of portable electronic devices and electric vehicles.<sup>[1]</sup> However, current LIBs composed of graphite and LiCoO<sub>2</sub> electrodes fail to meet the growing needs of automotive and battery manufacturers because of their limited specific energy densities.<sup>[2]</sup> Further improvement on battery performance depends on the developments of novel high-energy battery materials.

High-voltage spinel LiNi<sub>0.5</sub>Mn<sub>1.5</sub>O<sub>4</sub> (LNMO) oxide is a promising cathode for next-generation high-performance LIBs due to its high energy density (650 Wh kg<sup>-1</sup>), high operating voltage (~4.7 V vs. Li), and low fabrication cost. However, its wide application and potential commercialization is hindered by rapid capacity decay during cycling.<sup>[3]</sup> Understanding the structure-chemistry-function relationship of LNMO is crucial for figuring out the exact failure mechanism and designing highperformance LNMO materials. This article will use LNMO cathode studies as examples to highlight the importance of synchrotron-based radiation techniques in investigating the mechanistic behaviours of battery materials as well as the valuable insights into designing high-performance LIBs.

#### Synchrotron-based radiation techniques

# a. Synchrotron based X-ray powder diffraction (SXRPD)

SXRPD is a powerful technique to detect the phase transformation and structure evolution of active materials during battery cycling. However, such measurements cannot be performed using a conventional cell, with modifications such as an Xray transparent window are necessary for SXRPD measurements. Previous designs which used Be foil or polyimide film (Kapton tape, Figure 1a) as the window suffered from softening and oxidizing over time, especially at high voltages, resulting in measurements not representative of the typical behaviours of active materials of interest.<sup>[4]</sup> We successfully modified this design by replacing Kapton tape with metal tapes (Figure 1b) which achieve an electrochemical response comparable to the standard 2032-type coin cell, alongside the desirable long-term and high-voltage stability for in operando SXRPD measurements.<sup>[4]</sup>

Using this robust coin-cell design, we successfully evaluated the structure-function relation of LNMO cathodes (Figure 1c), determining that LNMO with Fd-3m space group symmetry undergoes a solid-solution reaction during the Ni<sup>2+</sup>/Ni<sup>3+</sup> redox couples at approximately 4.6V (vs. Li, from  $LiNi_{0.5}Mn_{1.5}O_4$  to  $Li_{0.5}Ni_{0.5}Mn_{1.5}O_4$ ) and a two-phase reaction during the Ni<sup>3+</sup>/Ni<sup>4+</sup> redox transformation when the voltage is above 4.7V (from Li<sub>0.5</sub>Ni<sub>0.5</sub>Mn<sub>1.5</sub>O<sub>4</sub> to Ni<sub>0.25</sub>Mn<sub>0.75</sub>O<sub>2</sub>).<sup>[5]</sup> The twophase reaction usually occurs through a nucleation and growth mechanism involving grain boundary movement, which negatively impacts the lithiation/delithiation processes. In contrast, the solidsolution reaction is more favourable owing to the moderate structural transformation and better cycling reversibility. Originating from these valuable insights, we propose site-specific structural engineering in LNMO, aiming to transform the two -phase reaction into a solid-solution one to enhance its structural stability. The initial attempts<sup>[5]</sup> targeted the tetrahedral 8a and octahedral 16c sites of Fd-3m LNMO, where 8a and 16c sites are associated with hazardous Mn dissolution and







Figure 1. Photo of the a) Kapton<sup>®</sup>-window and b) metal-tape-window cell caps; In operando SXRPD data showing the 111 reflection evolution of (c) LNMO, (d) Mg-doped LNMO, and (e) Sb-doped LNMO; Schematic crystallographic structure of the Sb-doped LNMO sample with marked Wyckoff sites

phase transformation, respectively. Successful site -specific modification was achieved by Mg dopants, since Mg can exist in both tetrahedral and octahedral coordination environments in nature. The battery capacity was further increased by modification of the tetrahedral 8a (active Li) sites which were replaced by that at the octahedral 16d sites (Figure 1e and 1f). The difficulties in simultaneous modification at both 16d and 16c octahedral sites lie in the ionic radius requirements of dopants occupying these sites, of which ions located at 16d sites need to have a radius similar to  $Mn^{4+}$  and  $Ni^{2+}$ , while those at 16*c* sites need to be large to avoid the structural collapse in the highlydelithiated state. Inspired by the variable ionic radii of octahedrally coordinated Sb in the antimony (III, V) oxides, we introduce Sb as a dopant in LNMO, directly addressing the site-specific modification at 16c and 16d sites. The Sb-doped LNMO with modifications at 16c and 16d shows smooth and symmetrical electrochemical behavior during charge/discharge, contributing to an impressive

99% of its theoretical specific capacity at 1 C and high-capacity retention (87.6% of initial capacity) after 1500 cycles.

#### b. X-ray absorption spectroscopy (XAS)

XAS is a technique which is sensitive to the electronic states of absorbing atoms in battery materials. The element-selective nature of XAS enables the determination of neighboring transition metals (TMs) individually, which is unfortunately beyond the capability of SXPRD. XAS spectra usually contain two regions, i.e. X-ray absorption near edge structure (XANES) and extended X-ray absorption fine structure (EXAFS). The XANES part reflects the unoccupied bond states accessible to the absorbing atom of interest in matter, yielding electronic information including oxidation state, geometry configuration, and chemical specificity. While the EXAFS one probes excitations of photoelectrons into the continuum, which can provide quantitative local structure information of matter, including bond distances, bond angles, coordina-







Figure 2. Mn K edge EXAFS spectra of (a) LNMO and b) Sb-doped LNMO samples at different voltage during the first charge; O K edge NEXAFS spectra of (c) LNMO and (d) Ge-doped LNMO at OCV, fully-charged and fully-discharged states; Mn L edge NEXAFS spectra of (e) LNMO and (f) Ge-doped LNMO before cycling and after 500 and 1000 cycles. Note that 4s-LNMO means Ge-doped LNMO.

tion numbers, etc.

For example, in the study of Sb-doped LNMO,<sup>[6]</sup> which features modifications at both 16*d* and 16*c* octahedral sites, we carried out ex-situ EXAFS studies at the Mn K edge to further explore the internal structural changes of different LNMOs during charge (Figure 2a and 2b). The two shells at ~1.4 and 2.7 Å correspond to the Mn-O and Mn-TM interactions, respectively, in the LNMO structure.<sup>[6]</sup> Notably, the full-width at half-maximum (FWHM) of Mn-O peak of the LNMO increases with increasing voltage, indicating more pronounced structural distortion during lithium extraction. In contrast, this peak is almost unchanged during the whole charge in the spectrum

of the Sb-doped LNMO sample, confirming a rigid spinel-type structure of Sb-doped LNMO that is tolerant to high-voltage charge, as consistent with the purely solid-solution reaction observed using SXRPD (Figure 1e).

#### <u>c. Near-edge X-ray absorption fine structure</u> <u>spectroscopy (NEXAFS)</u>

NEXAFS uses soft X-rays (100 - 3000 eV), which are well suited to measure elements with low atomic number, such as C and O at the K edge, and those with high atomic numbers, for example TMs, at the L edge. NEXAFS can be measured in both total electron yield mode and fluorescence yield mode, which correspond to a detection depth of ~10 and 100 nm, respectively, from the surface of the battery electrode materials.<sup>[6]</sup> Note that this information surface/subsurface obtained bv NEXAFS is insightful to probe the detailed reactions at the interface between electrode and electrolyte, especially considering the importance of the solid electrolyte interface (SEI) in controlling battery performance.

Typical O K edge NEXAFS spectra of LNMO materials was shown in Figure 2c and 2d, in which Peaks A and B in the pre-edge zone (528-534 eV) arise from the hybridization between O 2p and localized Ni/Mn 3d orbitals. Peaks C and D are associated with the hybridization of O 2p and metal 4s and 4p orbitals, respectively. Peak E has been widely reported as the fingerprint of carbonate species, critical components of the SEI. It is obvious that significant changes occur at all peaks in LNMO after charge and discharge, indicating irreversible reactions in the material structure and degrading electrochemical performance of the battery materials. To minimize these hazardous changes, we therefore introduce strong 4s-2p orbital hybridization into the LNMO structure, achieved by the introduction of  $Ge^{3+}$  dopants ([Ar]  $3d^{10}4s^{1}$ .<sup>[7]</sup> The modified LNMO material shows a well-maintained peak pattern with minor SEI formation (neglectable Peak E, Figure 2d) during cycling, confirming the significant contribution of the 4s-2p orbital interaction to oxygen stability. The





enhanced structure stability was also evidenced in the Mn L edge NEXAFS spectra. Pristine LNMO shows increasing characteristic peaks of Mn<sup>3+</sup> and Mn<sup>2+</sup> species upon cycling (Figure 2e), which are associated with the hazardous structural distortion. While the spectra of Ge-doped LNMO remain relatively unchanged even after 1000 cycles (Figure 2f). Therefore, using this example, the power of NEXAFS in detecting surface chemistry of battery materials is well exhibited.

#### Conclusion

The design of high-performance battery materials depends on the in-depth understanding of their mechanistic behaviours during electrochemical reactions. Synchrotron based radiation techniques, including SXRPD, XAS, NEXAFS, are powerful tools to build detailed structure-chemistryfunction relation of active battery materials and offer valuable insights into solving performance issues of materials of interest. In addition, the combination of findings from different characterization techniques should be considered in order to understand the complex battery system comprehensively. There is no doubt that the employment of synchrotron radiation techniques will lead to a significant leap in the rechargeable battery studies.

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 [7] Angew. Chem. Int. Ed. 2022, e202201969.

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### Laboratory XRD data reduction and conversion in Bragg-Brentano geometry for PDF analysis

Dr Tony Wang

Senior Research Infrastructure Specialist Central Analytical Research Facility Queensland University of Technology

Pair Distribution Function (PDF) analysis has become increasingly popular in laboratory-based diffraction facilities over the past few years due to the improvement of data reduction features and adaptions made to cater to laboratory diffraction data in variety of PDF generation software. PDF analysis, or in a broader sense, Total Scattering Analysis, has strengths in highlighting local structures or short-range periodicities from atomic neighborhood (<10 Å) to the whole crystallite (up to ~100 Å, depending on instrument resolution) [1 -3].

A laboratory instrument suitable for PDF analysis would use Mo Ka or Ag Ka radiation in Bragg-Brentano geometry, or preferably, in capillary transmission (Debye-Scherrer geometry) if equipped with an optic to focus the X-ray beam on the detector. A wide Q-range (Q =  $4\pi Sin\theta/\lambda$ ; > 17 Å -1) scattering pattern with a good signal to noise ratio needs be collected, together with a standard diffraction pattern to aid in identifying and modelling non-sample contributions such as holder/ capillary scatterings, air-scattering background, wavelength dispersion of laboratory radiation source, instrumental broadening of reflection profile etc. Another practical consideration is to remove any known impurity phases from the specimen pattern so that the subsequent PDF conversion can be applied just on the reciprocal space signals from the phase of interest.

The following procedure briefly describes the steps of laboratory XRD data reduction and conversion using three common PDF analysis software available to the author. The diffraction data of a nickel metal powder (GF69412170, Sigma-Aldrich) was collected using a Rigaku<sup>®</sup> SmartLab diffractometer in Bragg-Brentano geometry under MoKa





Figure 1. The screenshot of PDFgetX3 v2.2.1 command line interface for the nickel diffraction data

radiation (50kV 40mA). A Bragg-Brentano slit was used in the CBO module, followed by a 5° primary Soller slit, a 0.3° incident slit and a 10 mm height limiting slit. The front-loaded nickel powder sample was spun at 15 rpm during data collection. A Zr Kβ filter was used on the secondary side, followed by a 14 mm anti-scattering slit and a 5° secondary Soller slit. The diffraction data was collected from 2 to 154° 20 at 0.0052° step size over ~25 hours using a Hypix3000 detector operated in 1D mode at 20 mm PSD opening. There are other advanced measurement schemes in Bragg-Brentano geometry, like Dynamic Beam Optimization [4] and Variable Step Size and Variable Counting Time [5] etc. could improve data quality and reduced measurement time. But this report of laboratory PDF analysis is demonstrated on data measured using a simple Bragg-Brentano geometry for, hopefully, wide utilization.

PDFgetX3 is a well-known PDF generation software freely available to academics [6]. Although the software relies on Python Environment and is maybe not intuitive to users not familiar with command line operations, the advantage of PDFgetX3 lies in its algorithm which can automatically optimize convention parameters for PDF generation [7]. It only needs very basic information of the diffraction experiment from users, such as radiation wavelength, sample chemistry, Q and r ranges etc. This automatic algorithm makes the software able to handle batch PDF conversions, e.g. for 2D frames data collected using high energy synchro-



Figure 2. The screenshot of PDF Analysis for the same nickel diffraction data in HighScore Plus v5.1





Figure 3. Extraction of sample contribution (Green) from the same nickel diffraction data (Blue) in TOPAS v7 (Operation 0). Intensity axis shown in square root scale to highlight instrument contributions. Inset: PDF refinement for the generated G(r) at user specified r(Å) ranges

tron radiations. Unfortunately, the package seems to lack features removing contributions of the laboratory diffractometer from measured data. The nickel diffraction data loaded to PDFgetX3 command line operation (Figure 1) had K $\alpha_2$  peaks prestripped using Diffrac.EVA v6. PDFgetX3 does not perform PDF simulation nor PDF refinement. These features are available in xPDFsuite [8], which is a commercial package from the same author group.

The same nickel diffraction data collected in this experiment were converted into PDF in HighScore Plus (Figure 2), which is another comprehensive XRD data analysis package [9]. The software can automatically process XRDML data formats collected using variable counting time and remove wavelength dispersion, including K $\alpha_2$ peaks and bremsstrahlung humps etc. Although the PDF calculation and refinement function is not yet available, the software is able to index the generated PDF G(r) peaks (red curve in Figure 2 bottom graph) with an atomic bond histogram (blue sticks in Figure 2 bottom graph) calculated from the phase's unit cell.

TOPAS is a software known to be able to deconvolute specimen contribution from instrument contributions in measured XRD patterns, using either the Fundamental Parameter Approach [10] or Parametrization method from standard patterns. Since version 7, this method has evolved to be able to directly strip off instrumental contributions from measured XRD pattern, leaving only the specimen contribution, without knowing any specimen information [11]. With this advantage, almost all the contributions from a laboratory diffractometer, together with any impurity peaks, can be removed in a single operation (Figure 3), so that TOPAS can calculate the PDF from just the reciprocal space signals from the phase of interest. The generated PDF can also be fit using the refinable crystal structure of this phase (Figure 3, inset).

This technique has also been applied to compare the local structure similarity between simonkolleite and another recently solved zinc hydroxide chloride tetrahydrate structure (hereafter: SJ-6) [12]. As shown in Figure 4, converting the apparently different XRD patterns of these two phases into PDF G(r) reveals certain degree of local bond similarity (<12 Å) between simonkolleite and SJ-6. This finding supports the solved crystal structure of SJ-6 (ICSD# 133386) which has similar layer structure as simonkolleite, but four interlayer water molecules rather than one interlayer water









#### molecule [12].

Because of its high intensity and high angular resolution from the para-focusing setup, Bragg-Brentano geometry is the most common configuration of laboratory diffractometers. With the improved convenience of laboratory data processing using Bragg-Brentano geometry for PDF analysis, any laboratory diffractometer with Mo or Ag target X-ray tube can perform PDF data collection. Nevertheless, intensity deviations due to preferred orientation issue from front packing of powder particles of high aspect ratios, commonly seen in Bragg-Brentano geometry, will deteriorate the accuracy of generated PDF G(r). For those crystals, capillary transmission (Debye-Scherrer) could still be the most suitable measurement geometry.

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#### 2023 SPECTRA<sup>plus</sup> School - Australia

Our SPECTRA<sup>*plus*</sup> School Australia is scheduled to take place in Sep/Oct 2023 at our training facilities in Preston. This hands-on course is an introduction to SPECTRA<sup>*plus*</sup> Version 3/4 for WDXRF systems, and will cover alignment, calibration and maintenance. To facilitate interaction between participants and trainers, limited seats are available on a first-come-first-serve basis.

Register your interest and get more information here:

https://www.bruker.com/en/services/training/elemental-analyzers/application-trainings/spectraplus-school-au.html

### Upcoming Webinar on 6 July (Thurs), 5:00 PM AEST

#### 3D X-ray Microscopy: A non-destructive technique to explore deeper in geomaterials

X-ray microscopy, based on micro-computed tomography technology (micro-CT), is a 3D imaging technique that can reveal microscopic structures inside matter. The nondestructive nature of this technique makes it possible to map 2D and 3D spatial distribution of surface and internal features of interest such as pores, minerals, grains, etc. Advanced image-based analysis methods pro-



vide a powerful tool to measure properties such as global and local pore/grain size distribution, structure thickness, feature shape and orientation. Integrated heating/cooling platforms and mechanical testing stages are additional plug-ins to simulate, capture and study events such as weathering and strength of materials. This will be a 90-min live webinar.

Register here: <u>https://bit.ly/axaa3dxrm</u>

### Q2XAFS 2023 International Workshop on Improving Data Quality and Quantity in XAFS Spectroscopy

Q2XAFS is a symposium series bringing together experts in the field of X-ray Absorption Spectroscopy to discuss aspects of the technique that affect data quality in XAFS experiments.

DateThu 17 Aug at 9.00am - Fri 18 Aug at 5.00pmCostAU\$150 (full), AU\$100 (students)VenueAustralian Synchrotron, ANSTO<br/>800 Blackburn Road, Clayton VIC 3168

This will be an in-person only event More information and registration here







#### **Aeris Compact XRD**

26 May

Conducted online

This 1-day programme will cover sample preparation, instrument performance verification as well as practical knowledge for before, during and after XRD measurement. These include instrument set up, measurement program optimization and measurement execution. Our application specialist will also cover the data quality evaluation and overview of the data analysis. For in-depth data analysis join our Powder XRD data analysis programme in June. Tell us if prefer an in-person training https://tinyurl.com/AerisTraining

**Suitable for:** Existing users of Malvern Panalytical Aeris benchtop XRD. The basic knowledge of XRD is beneficial, however, not required.

Academia / Early bird rate: \$2,500 (Ends 2 months prior | UP \$2,800)

#### Powder XRD Data Analysis Training Using HighScore Plus

12 - 16 June

Conducted online

Learn about XRD data analysis and application from our application specialists and HighScore Plus software developer. During this 5-day course, we will cover topics including how to interpret powder XRD data alongside application examples, phase quantification using the Relative Intensity Ratio (RIR) and Direct Derivative Method (DDM), quantification of amorphous content using PONKCS, K-factor, crystallite size & micro-strain, indexing and structure solution as well as tackling large data sets using automated batch analysis and more. During the session, you may also book one-on-one sessions with our specialists to discuss your challenges and sample analysis.

**Suitable for:** Existing users of Malvern Panalytical XRD or anyone interested to learn more about XRD applications and analysis using HighScore Plus software. It is expected that participants are equipped with basic knowledge of XRD

Academia / Early bird rate: \$2,500 (Ends 2 months prior | UP \$2,800)

#### **XRF in the Workplace**

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15<sup>th</sup> – 19<sup>th</sup> May | 6<sup>th</sup> – 12<sup>th</sup> November

Conducted live in Perth, Western Australia

This is the 20<sup>th</sup> year that we've run this course. Building on our experience, we provide an introduction to XRF elemental analysis which serves to build your foundational knowledge in the XRF technique and spectrometer. This is so you can excel during the hands-on practical sessions from sample preparation to analysis.

**Suitable for:** Anyone new to XRF or those who want a refresher. Programme is XRF brand agnostic, so all users of XRF may apply.

Academia / Early bird rate: \$4,000 (Ends 2 months prior | Usual price: \$4,500)



# AXAA Community News









# Australian X-ray Analytical Association

### AXAA Networking Day – Melbourne

Join us for a day of talks, prizes, and a morning tea sponsored by Dectris at the Australian Synchrotron! This will be an excellent opportunity to hear from others in the X-ray community and check out Australia's favourite particle accelerator.

When: Friday 9th June, 9:00 AM

**Where**: Australian Synchrotron, Clayton VIC **How to attend**: A registration link will be sent from the AXAA mailing list, keep an eye on your inbox!

#### **Attention Melbourne Students!**

Do you use X-ray or neutron techniques in your work? We'd love to hear from you! Prizes will be on offer at the AXAA student networking day for best talk. **To apply, send an abstract (<300 words) to ausxray@gmail.com by 23rd May** 

#### **Our Keynote Speakers:**



**Dr Niloofar Karimian** (CSIRO) will be speaking on applied X-ray techniques in environmental geochemistry.



**Dr Justin Kimpton** (ANSTO) will provide an update on the Advanced Diffraction Beamlines at the Australian Synchrotron.

# High Purity Alumina for QXRD

Independent Mineral Standards (IMS) is a specialist producer of Certified Reference Materials, (including mineral reference materials). Driven by data and world leading expertise, we service the global mining industry.

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# **XRF - XRD Sample Preparation**

Rowe Scientific are now exclusively supplying the SOMAR brand of Australian made XRF pellet cups.

We have purchased the assets of SOMAR Australia and incorporated their pellet cup manufacturing into our Perth Facility.



# **XRF Liquid Cups**

These cups allow the analysis of solutions by XRF, and fit all common makes of XRF instruments, including X-Unique II, PW2400, PW2404, Axios, and many PANalytical instruments.

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## 3D X-RAY MICROSCOPY SKYSCAN 2214 CMOS Edition

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Innovation with Integrity



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### **AXAA Membership**

All registered participants of the AXAA-2017 conference are automatically granted AXAA membership for 3 years. Alternatively, new memberships can be obtained free of charge, by making an application to the National Council.

Candidates should send the membership form from the <u>AXAA website</u>, and a short statement about how they intend to contribute to the organisation, to the National Council Secretary Anita D'Angelo.

#### **AXAA Resource Centre**

There are a range of resources available on the <u>AXAA website</u>, including video recordings of the two Public Lectures at AXAA-2017, tips for Rietveld Analysis, Clay Analysis, XRF tips, and more. We welcome further contributions to our Resource Centre.

#### Next AXAA Newsletter

The next issue of the AXAA Newsletter will be distributed in August 2023. Please feel free to send contributions for the newsletter to Valerie Mitchell at *ausxray@gmail.com*. Any comments or feedback about the Newsletter are welcome.

### A Day in the Life of an X-ray / Neutron Scientist

We are seeking posts for our 'Day in the Life' series. If you'd like to contribute, or know someone who might be interested, please contact National Council

