Newsletter 2 (PCIG N2) - 26.08.2023

Welcome to the second edition of our newsletter!

PREFACE

This newsletter aims to serve as a means of internal communication of useful information and strengthen the engagement among the group members. This quarter's newsletter with the second edition (May – August 2023) consists of three main sections:

A. Research highlights, which represents the emerging technologies in particle characterisation.

B. People focus, which reveals the motivation and sharing from different researcher members.

C. Update corner, which summarises the new events, collaboration, and other opportunities.

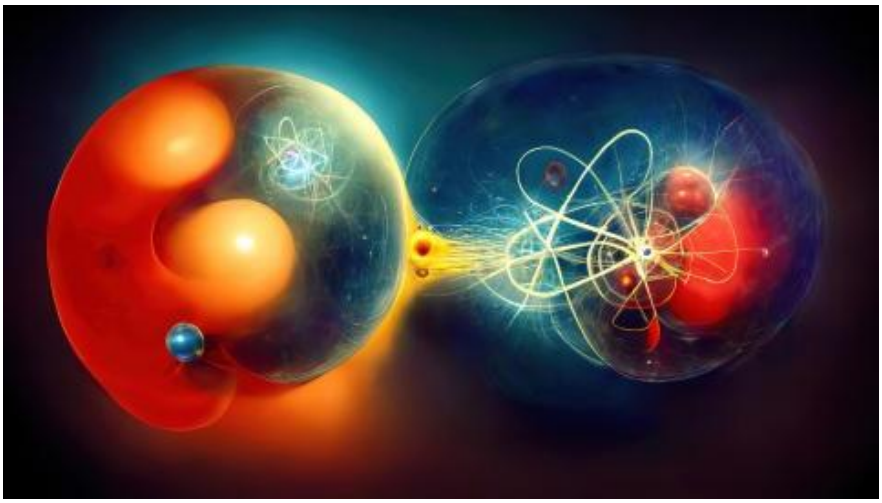
Our current edition team includes **Tien Thuy Quach, Merel Bout, and Mel Disher**. We would like to express great appreciation to **the PCIG Committee** for encouraging and advising us to issue the second edition of PCIG Newsletter. Many thanks for the contribution from the people who are willing to cooperate with us. We look forward to your collaboration in the next editions!

Welcome to the PCIG Newsletter,
where we network and work together for better particle technologies.

A. RESEARCH HIGHLIGHTS

Elemental particles: our building blocks

Written by Merel Bout



Portrayal of a particle with their subatomic building blocks (electron, proton, neutron and quarks and leptons) (Image Credit: Rick / Adobe Stock)

In our second newsletter's exploration of particle characterization, we delve into the fundamental building blocks of matter and in particular particles. Particles are composed of atoms, but even atoms are made up of smaller components. For a long time, it was believed that the smallest components were protons, neutrons and electrons. However, half a century ago in 1964 (just two years before the PCIG was founded!) even smaller building blocks were found within protons and neutrons: these particles were named quarks. Below a short overview of these (sub)atomic building blocks that make up the bigger particles that are typically of interest to particle characterisation.

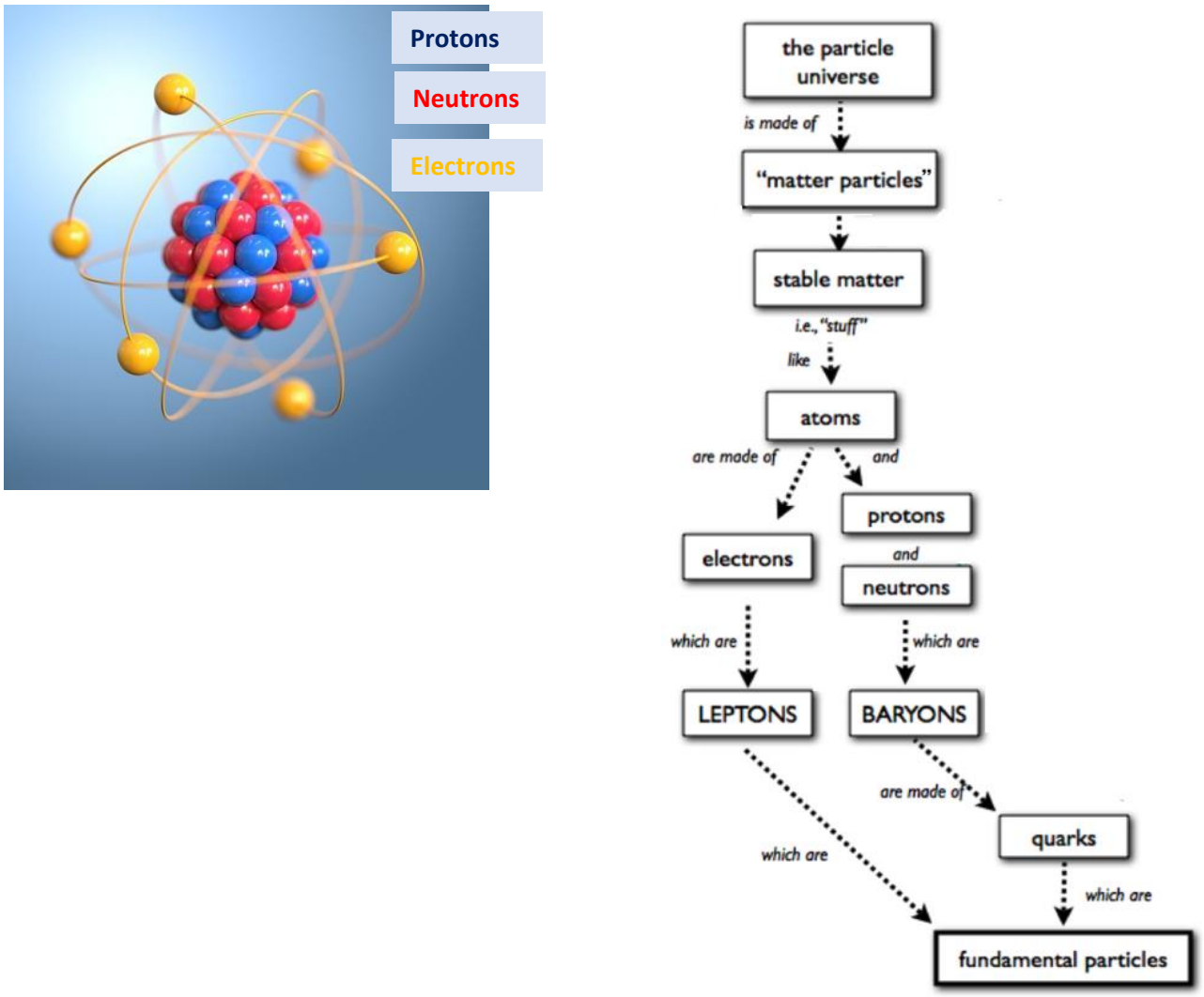
Neutrons: The Silent Stabilizers of Atomic Nuclei

At the heart of every atom lies the nucleus, composed of neutrons and protons. Neutrons, as their name suggests, are electrically neutral particles. Alongside protons, they form the backbone of atomic stability. While protons carry a positive charge, the neutral nature of neutrons helps counteract the electrostatic repulsion between protons, maintaining the integrity of the atomic nucleus. Neutrons play a crucial role in defining the isotopes of an element, as variations in the number of neutrons give rise to different atomic masses.

Protons: The Positive Powerhouses

Protons, in contrast to neutrons, carry a positive electrical charge. They are essential in determining the atomic number of an element, which defines its unique chemical properties. The number of protons in the nucleus dictates an element's position in the periodic table and

its fundamental characteristics. The remarkable stability of atomic nuclei, despite the mutual repulsion between protons, is a result of the intricate balance between attractive nuclear forces and electromagnetic repulsion.



Simplified map from Physics for the 21st Century, The Basic Building Blocks of Matter (Image Credit: koya79/ Getty Images)

Electrons: The Fundamental Charge Carriers

At the heart of matter lies the electron, an elementary particle with a negative electric charge. Electrons are found orbiting the nucleus of atoms and play a crucial role in electricity, magnetism, and chemical bonding. With a mass approximately 1/1836 times that of a proton,

electrons are incredibly lightweight. They are indivisible and not known to be composed of smaller constituents, making them truly elementary particles.

Subatomic particles

Quarks: The Building Blocks of Protons and Neutrons

Delving deeper into the subatomic structure, we encounter quarks — the fundamental constituents of protons and neutrons, which form the atomic nucleus. Quarks come in six distinct types: up, down, charm, strange, top, and bottom. Each type possesses different properties, such as mass and charge, which contribute to the diverse nature of matter. Interestingly, quarks never exist as isolated entities in nature — a phenomenon known as colour confinement. Instead, they combine to form composite particles such as protons and neutrons. Protons and neutrons are called baryons which are a collection of three quarks.

Leptons: The Electrifying Family

Next are leptons — a family of elementary particles that includes the familiar electron, along with two heavier counterparts: muons and taus. Leptons are electrically charged, with the electron carrying a negative charge and the muon and tau carrying the same charge, albeit with significantly greater mass. Neutrinos, intriguing members of the lepton family, are electrically neutral and have extremely tiny masses. Neutrinos interact weakly with matter, making their detection a fascinating challenge for physicists.

The study of subatomic particles and their interactions plays a crucial role in understanding particle characterisation, physics, cosmology, and the behaviour of matter in the universe.

This article has described only a small portion of the total number of different particles involved in matter relevant to the behaviour of matter. The realm of subatomic particles is far more expansive and often intertwined with quantum mechanics (e.g antiparticles and bosons have not been described here).

In future newsletters there will be more information about this fascinating field and the latest developments and applications will be explored.

References:

(1) https://www.entegris.com/en/home/resources/industry-insights/general-particle-sizing.html

(2) https://bigthink.com/hard-science/quarks-leptons-smallest-particles/
(3) https://www.livescience.com/37206-atom-definition.html
(4) https://www.learner.org/wp-content/uploads/2018/12/physics-for-21st-century-basic-building-blocks-matter-facilitators-guide.pdf

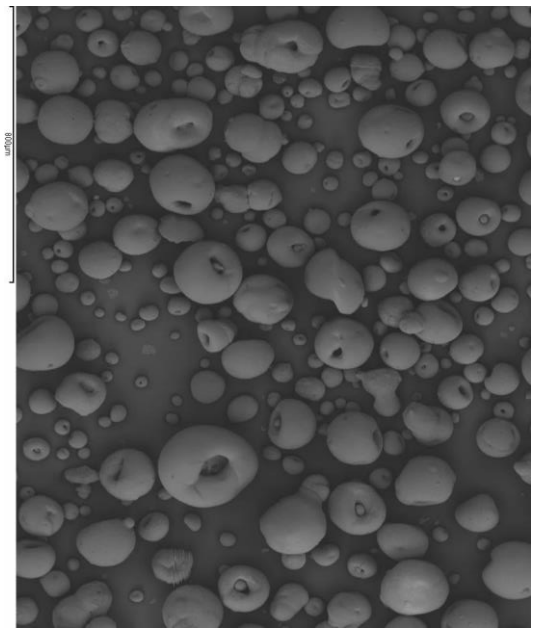
Techniques Behind Understanding Particle Properties

Written by Phil Jackson

One of the questions the PCIG committee has been grappling with recently is “what range of particle characterisation techniques should PCIG cover?”. In helping us answer this question, feedback on a questionnaire we recently sent out to interested parties has proved very insightful.

Many people tend to think of particle size, particle shape as well as surface area and dry powder flow as key characterisation techniques. Indeed, PCIG has for many years provided training in the correct measurement of these properties. However, powders are commonly processed as liquid suspensions. As an example, depicted below, fluid fine powder suspensions can be spray dried to create larger granulates that are subsequently pressed into a product (a pharmaceutical tablet or a ceramic wall tile).

Spray Dryer



Scanning Electron Microscope image of granulate

Equally, a coating often comprises a slurry of powder in liquid that is sprayed or dipped onto a substrate before consolidating with heat or UV light. At the very least then, powder suspensions (as well as the dry powder starting material) should be monitored for particle size. Agglomeration in the dry powder state is overcome in suspension, especially if surfactants are used. Powder suspensions also open up additional characterisation techniques that are vital for QC and product development purposes. Returning to spray drying, the rheology and surface tension of a powder suspension will play a key role in defining how well it is pumped to the nozzle and how it breaks up into droplets during atomization. The rheology (in aqueous systems) will in turn be influenced by zeta potential (the surface charge a powder assumes in water) as this controls flocculation vs deflocculation.

When smaller amounts of liquid are present in powder suspensions, we encounter the field of pastes capable of being extruded into shaped products. Should the use of capillary rheometer to characterise pastes be included under the theme of powder characterisation?

Taking deliberations further the next question could be “What is a particle suspension”? Is it only a solid powder particle in a liquid or could / should the analysis of liquid droplets in liquids (emulsions) or bubbles in water be considered a particle suspension? Past events organised by PCIG have attempted to embrace all three scenarios.

It is clear then that powder characterisation is a very broad field, covering techniques that are immediately associated with powder testing as well as other perhaps more peripheral offerings. Ultimately it is important that researchers and industrialists are aware of the widest range of analytical techniques possible, pulling together the most relevant ones on a case-by-case basis. Therefore, as well as providing awareness of different analytical techniques, an important aim for PCIG is to share case studies on how a suite of analytical techniques were chosen to help develop a new product or maximise yields in an existing product.

Measuring the right properties in powders and powder suspensions allows a thorough exploration of material/processing variables and how this impact final product quality further down the line. Taking an example from my own experience, cements used in a medical setting sometimes experience syneresis: this is where, over time, the liquid and powder phases become separated despite appearing to be well blended at time zero. Conventional plate-on-plate rheometry (see image below) generating shear stress vs shear rate profiles was unable to differentiate between formulations that were sound as opposed to vulnerable to syneresis.

Plate on Plate Rheometer

Hammer Mill

However, turning to oscillatory rheometer (and using centrifugally induced sedimentation analysis for correlation studies) proved successful. Having identified a sound analytical technique to quantify end product behaviour, the next logical step is to employ Design of Experiment (DoE) software to explore the impact of both materials variables (e.g. wt% powder, powder PSD and liquid phase viscosity) and processing variables (such as rotator geometry and rotator speed associated with Hammer Milling - see photo above). Ultimately a design space corresponding to a satisfactory end point can be established (e.g. good cement shelf-life). The literature has plenty of examples showing how DoE combined with sound powder testing has helped to generate better products. Interested readers are referred, for example, to the reference below where a topical cream was optimised to maximise the transfer of Quercetin (an antioxidant, anti-bacterial and anti-inflammatory active) into the skin.

Reference:

"Development of Olive Oil containing phytosomal nano-complex for improved delivery of Quercetin: Formulation Design Optimization, in-vitro and ex-vitro appraisals". Mohammed Elmowafy et al. *Pharmaceuticals 2023, 15(4), 1124*

B. PEOPLE FOCUS

Get to know

We can understand the research interest and career pathways from our PCIG members. We will start with an overview of two of the Committee members, but please contact us to share your background and experience in future newsletters.

Chris Williamson BA, FRSC

"I have over 40 years of in-depth technical and professional experience acquired from extensive periods in drug discovery, development projects and outsourcing programmes (exclusively within GlaxoSmithKline) and as an independent consultant."

My chemistry degree was from York in 1973 and I went straight to work as an organic chemist at Glaxo, Greenford. In Medicinal Chemistry I discovered hundreds of new compounds for which the biological purpose hasn't yet been discovered (that's to say they were useless in the specific tests they were made for but who knows what awaits random screening!).

One particularly amazing new compound I made was a steroid thio-acid which led to fluticasone (Advair/Seretide) which has helped millions with their asthma (not bad for an experiment which went wrong – I was trying to make an amide!). In Chem Dev I had the privilege to lead the team which provided all the clinical trial material for zanamivir (Relenza) and we developed the commercial manufacturing process. In Manufacturing I led the technical team responsible for a diverse range of API source and supply chain changes into the Secondary network. During this period, I contributed to the ISPE "Good Practice Guide: Technology Transfer".

My job as Technical Director was made redundant in 2009 but that gave an opportunity for greater involvement with the RSC as Secretary or Chairman of the Downland Local Section until July 2022. I was also Chairman of the RSC SE Regional Steering Group Committee and

a member of the RSC Networks Committee and RSC Member Communities Board. I was honoured to receive an Exceptional Service Award in 2021 as part of the volunteer network. My scientific interest in particle characterisation stems from numerous conversations in project teams where our downstream colleagues asked us to “make it the same”, without either party being really clear on what were the essential characteristic/s of the material which made it suitable or not.

I've not been an active member, or really even an active follower, of the Particle Characterisation Interest Group since I ticked the box for one of three free groups as part of my annual membership. It was simply the e-mail of 4 August from the Networks Team calling for a new chair and four new committee members which piqued my interest. I've just completed 12 years on another RSC committee and now have time to devote to an area of science which in my opinion still has room for further knowledge and understanding.

Phil Jackson

“Subsequently my work broadened to other ceramic sub-sectors with a focus on powder characterization and control. I was instrumental in initiating, writing and then managing 30+ public funded projects (both UK Government and EU funded, the later under Framework IV, V, VI).”

I have a degree in Chemistry and a PhD in thermodynamics (1983 and 1988 respectively, from University of Leicester). Since 1986 I have worked for Lucideon Limited (formerly British Ceramic Research Limited; Ceram Research). Initially I was involved in R&D projects relating to novel Ceramic Whiteware glazing and decoration.

I played a key role in developing unleaded glaze formulations in the late 1980s / early 1990s as legislation initiated in the US threatened to ban the use of lead in glazes. As the UK ceramic industry declined, the company reinvented itself as providing general materials testing and consultancy support. In line with this change, I have largely worked in consultancy, leading a team supporting the healthcare and consumer product sectors. projects deal with optimisation of existing products, development of novel analytical approaches to test / differentiate products

(claims support) or novel product development. A key aspect of our work involves the use of Design of Experiments (DoE) - working with clients we defined key “variables” (powder raw material properties and / or process variables) and “responses” (measured end-product properties). Using DoE software, we devise and then conduct a series of experiments before using the “response” data to generate optimisation models that show likely products performance in multi-dimensional design space. I have worked on a wide range of commercial products including toothpastes, shampoos, bone cements, bone implants, denture fixatives, pressed pharmaceutical tablets, kitchen cleaning creams and medical device adhesives.

I have recently been involved in research to develop systems for additive manufacturing of ceramics. In this sphere, characterisation of ceramic powder, ceramic inks and extrudable forms of ceramic (polymer-ceramic composite; ceramic+solvent blends) is critical to success. I have also contributed to a patented technology called “inorganic controlled release technology”. Based on glass or sol-gel materials, the technology has been proven to deliver comprehensive encapsulation of actives and (via controlled chemistry / structure) a tailored active release profile vs time. The technology also has abuse-deterrence advantages. The powder is compatible with tablet pressing.

Between 2003 and 2014 I worked one day a week for Powdermatrix, a networking initiative that ultimately sat under the UK’s Knowledge Transfer network. My role as a technology translator saw me visiting companies to understand their challenges with powder generation and processing. Powdermatrix then created seminars, workshops etc. to help educate producers and users of powder products. We also funded many £5k Spark awards to stimulate SMEs to work with experts in powder processing to solve processing challenges. It was during this time that my involvement with PCIG started. In 2018 I was honoured to receive the IOM3 Roy Holland award for R&D services to the traditional ceramics sector. I have recently moved to part-time work as a transition to retirement.

Inspiring stories

Do not hesitate to share your stories to motivate other researchers and students. You can write about the people, the events that motivated you throughout your learning, working and research (either the good or the bad things happened). We look forward to hearing from you.

C. UPDATE CORNERS

Funding your conference attendance

Written by Mel Disher

(Image credit: The workspace)

PhD students often face financial challenges when it comes to funding conference attendance. However, there are several ways to secure funding to cover the costs. Here are some strategies to consider:

1. University Funding: Many universities have funds set aside specifically to support graduate student travel and conference attendance. Check with your department or university's graduate school to see if they offer any grants, travel awards, or scholarships for conference expenses.
2. Research Grants: If your research aligns with the conference topic, you may be able to apply for research grants that include funding for conference travel. Consult with your academic advisor or department to explore available grant opportunities.
3. Departmental Support: Some academic departments may have their own funding options or be willing to contribute to conference expenses for their PhD students. Speak with your department chair or advisor to inquire about any available resources.
4. Student Associations and Societies: Many academic societies and associations offer travel grants or subsidies for student members attending conferences. Become a member of relevant organisations related to your field of study and check if they offer such opportunities.

The Royal Society of chemistry offer such opportunities, discover more using the following link: https://www.rsc.org/prizes-funding/funding/find-funding/

5. Teaching or Research Assistantships: If you have a teaching or research assistant position, you may be eligible for funding or support from your department or supervisor. Discuss the possibility of funding for conference attendance with your supervisor.
6. Travel Awards and Scholarships: Keep an eye out for external travel awards and scholarships specifically designed for graduate students attending conferences. Some organisations, private foundations, or governmental agencies offer financial support for academic travel.
7. Crowdfunding and Fundraising: Consider starting a crowdfunding campaign or reaching out to family, friends, and colleagues to support your conference attendance financially. Many people are willing to contribute to academic pursuits.
8. Industry Sponsorship: If your research has practical applications and is relevant to a particular industry, some companies or organisations may be willing to sponsor your conference attendance in exchange for exposure or collaboration opportunities.
9. Volunteering at the Conference: Some conferences offer volunteer opportunities where you can help with organising the event in exchange for reduced registration fees or other benefits.
10. Reduced Registration Fees: Some conferences offer discounted rates for students. Make sure to inquire about student rates when registering.

When seeking funding, be proactive, and start planning well in advance. Deadlines for funding applications and conference registration can come up quickly, so make sure to plan ahead and explore all possible funding sources to increase your chances of securing support for your conference attendance.

Other news

Feel free to share with us your news related to professional and/or personal development! They can include training-career opportunities, research collaboration, new grants-awards, and other types of events-activities.

CONTACT US

Visit our website for further information: **https://www.rsc.org/membership-and-community/connect-with-others/through-interests/interest-groups/particle-characterisation/**

Do you have any questions, feedback or are you willing to contribute as a collaborative writer? Please email the RSC-PCIG Particle Newsletter Team via: **Particlenewsletter@gmail.com** and we will get back to you.