ISSN 2050-0432

RSC INTEREST GROUP
HISTORICAL

Historical Group

NEWSLETTER
and
SUMMARY OF PAPERS

Editor: Dr Anna Simmons

No. 89 Winter 2026

Registered Charity No. 207890

COMMITTEE

https://rschg.qmul.ac.uk
https://members.rsc.org/site/content/Community/InterestGroups/HistoricalGroup.aspx

RSC Historical Group Newsletter No. 89 Winter 2026

Contents

From the Editor

Welcome to the winter 2026 Royal Society of Chemistry Historical Group Newsletter which brings readers a selection of short articles, reports and news on the history of chemistry. This will also be my final issue as Newsletter Editor. I have thoroughly enjoyed editing the group's newsletter – it has been a wonderful opportunity to help showcase and develop the group's activities; extend my networks in chemistry and the history of chemistry; and crucially enthuse people about the history of the subject. However it is time for someone new to take on this challenge.

As Group Chair John Nicholson mentions elsewhere in this newsletter, this is an opportunity to share the workload involved in bringing the newsletter together. If you are interested in volunteering, please contact our new newsletter email address: historicalgroup.newsletter@gmail.com. This is also the email address to use going forward if you would like to contribute items such as short articles, book reviews, news items or reports to subsequent issues. Please do keep sending in suggestions of articles or items you would like to share with the rest of the Historical Group. The newsletter relies on contributions from its members! Suggestions for our series "Two Books that Markedly Influenced My Chemical Career" are particularly welcome. The deadline for the next newsletter will be **Friday 5 June 2026**. Members receive e-alerts from the RSC when the newsletter is published and please also look out for the newsletter on both the RSC and Queen Mary Historical Group websites:

https://members.rsc.org/site/content/Community/InterestGroups/HistoricalGroup.aspx

or https://rschg.qmul.ac.uk.

With a change in editorship ahead, it seems appropriate to include Peter Morris' brief history of the Historical Group Newsletter in this issue. This is followed by a broad selection of historical articles covering chemical education, chemistry in medicine and the chemical industry. John Nicholson reflects on two books that influenced his chemical career, writing about the school textbook *Nuffield Advanced Science: Chemistry Students' Book* and Courtenay Phillips and Bob Williams' classic undergraduate textbook *Inorganic Chemistry*. Alan Dronsfield and Pete Ellis look at the usage of the dye methylene blue in medicine. Inspired by the recent commemorations of the 200th anniversary of benzene, former Staveley Chemicals Ltd. employee, Ronald Presswood explores the benzene refinery products

made at Staveley Works in Derbyshire. Anthony Travis looks at the implications of the Discovery of PFAS ('Forever Chemicals') in Biological Materials. Michael Jewess discusses concepts of chemical bonding in the first half of the twentieth century. There is a also a review of Peter Morris' recently published book, *The Polymer Revolution – A Journey Through Polymer Science* and a report of the group's meeting on the History of Astrochemistry. Summaries of the group's popular monthly Tuesday online seminars are included, along with details of a meeting to remember the historian of chemistry, Bill Brock and information on the next conference of the International Society for the Philosophy of Chemistry.

The next Historical Group Meeting will belatedly celebrate the group's fiftieth birthday and will take place on **Tuesday 10 March 2026**, 10.00-16:45, at Burlington House. We hope many group members will join us to mark this special occasion. The meeting will reflect on social and scientific changes in chemistry since 1975 and also include a talk on the group's history. Full details appear later in the newsletter. Please also put **Friday 16 October 2026** in the diary. This is the date for our meeting on Chemists as Politicians.

I would like to finish by thanking everyone who has contributed to the newsletter during my tenure as editorship, whether it has been as an author, reviewer, or sharing news items or details of history of chemistry activities and publications. Particular thanks must go to Gerry Moss for his assistance in pagination and production throughout, to Bill Griffith and Alice Halman as membership secretaries and to all members of the historical group committee throughout my fifteen year editorship. It has been a pleasure to edit the newsletter and I look forward to reading future issues.

Anna Simmons, UCL

RSC HISTORICAL GROUP NEWS

From the Chair

One of the activities we offer to members of the Historical Group is the monthly (except August) webinar on a topic in the history of chemistry. This was an initiative from the time of the Covid pandemic and has therefore been running for over five years. The driving force behind these webinars has been Peter Morris, but he has now decided to stand down from his role as their organiser. These webinars have taken considerable work, and we thank Peter for his efforts. He has been responsible for arranging all the speakers, as well as for the publicity for each talk.

At the moment, we are not quite clear about what the future holds for these webinars. Ideally we would like them to continue, not least because they have proved so popular with members of the Historical Group. But, finding a way to carry on is challenging. We have a small group drawn from the committee considering this question, and we hope to bring you news of our plans some time in the new year. Meanwhile, we offer our heartfelt thanks to Peter for his hard work on these webinars, and for establishing what has become such a successful programme.

Another significant change is that this is the last Newsletter that will be edited by Anna Simmons. The Newsletter has grown in scope and quality in the years that Anna has been the editor and I often say that the word "Newsletter" does not do justice to the current quality of the publication. Currently we do not have a replacement editor able to take over from Anna, and we are considering the way forward. This is an opportunity to make some changes to the way the Newsletter is produced, and to share the work involved. We hope to have some news on all these points during the new year as well. For now, we thank Anna for her hard work and commitment to the Newsletter, and for all that she has done to raise it to such a high standard.

Lastly, we have become increasingly aware of the difficulties in finding information about the Historical Group on the RSC website. We have had direct discussions about this with the relevant member of the RSC staff, and found considerable sympathy for our concerns. The problem is that the website has recently been revamped and this has led to a number of unexpected complications. We will continue to add our voice to calls for the website to be improved and for access to subject groups' pages to be more straightforward. If you have encountered problems with the website, please let me know, and I can use the information in support of our efforts to encourage the RSC to improve things.

John Nicholson

Secretary's Report for 2025

The Historical Group held a one-day scientific meeting at Burlington House, London in October 2025 on the History of Astrochemistry. The meeting was held in-person and was open to members and non-members. It was a survey of the history of astrochemistry from the early history of astronomical spectroscopy to laboratory astrochemistry, including element abundance, element synthesis, interstellar molecules and chemical analysis of extragalactic systems. The meeting was held in collaboration with the

RSC/RAS Astrochemistry Group and the Society for the History of Astronomy (SHA). There was no March meeting in 2025.

Full reports of our meetings have been published in the RSCHG Newsletter, two issues of which appeared in 2025. This publication has continued to be edited by Anna Simmons and is something we are particularly proud of. Anna has maintained a consistently high standard and has succeeded in attracting a wide range of articles, meeting reports and other news items. She deserves all our thanks.

In addition to the one-day meeting, Peter Morris continued to organise our highly successful online lecture series on the third Tuesday of the month (August excepted), and these covered a wide range of topics on the history of chemistry. They continue to be well attended; audiences typically being up to around sixty participants, with people taking part from all over the UK and beyond. We thank Peter for organising these webinars.

Two committee meetings were held during the year, both of which were virtual and this is likely to be our pattern for the foreseeable future.

Our committee member, Vincent Daniels retired from the committee in October 2025. We are very grateful for his service to the committee. We are pleased to welcome several new members who joined the committee during the year, including Martin Bigg, Linea Soler and Joe Stanley.

At the end of 2024 Peter Morris stepped down as Secretary and since then I have taken over in that role. I am most grateful for the support and assistance that I have received from Peter and others through 2025 as I become familiar with this new role.

Mike Leggett

Message from the Membership Secretary

If you have recently joined the group, our membership secretary, Alice Halman, sends a warm welcome. To find out more about the group, please visit our website or LinkedIn page and look at the contents of the newsletter. We hold speaker meetings at Burlington House and also monthly webinars and it would be lovely to see you at any of these. If you have any questions about group membership or have ideas about improving member engagement or suggestions of topics for future meetings, please contact Alice on alicemhalman@hotmail.com.

Alice Halman

RSC Historical Group Newsletter Digital Archive

The RSC have created a digital archive for past issues of the RSC Historical Group Newsletter and pre-2010 issues will be added as they became available. The Historical Group's series of Occasional Papers, which cover topics including the organic chemist and Nobel Prize winner, Robert Burns Woodward (1917-1979); Thomas Beddoes (1760-1808) and the Medical Pneumatic Institution in Bristol; and Nitrogen Chemistry in Germany, 1900-1918, can also be found in the digital archive:

https://members.rsc.org/site/content/Community/InterestGroups/IG_Subpages/Historical_Group_Archive.aspx

Please note that after the introduction of a new RSC website during 2025 all URLs to RSC Historical Group webpages have changed.

RSC HISTORICAL GROUP MEETINGS AND ONLINE LECTURES

Fifty Years of Chemistry – Celebrating the 50th Anniversary of the RSC Historical Group

This one-day in-person meeting organised by the Historical Group will take place on **Tuesday 10 March 2026**, 10.00-16:45, at Burlington House, Piccadilly, London W1J 0BA. The Historical Group was founded by Stephen Mason, the Professor of Chemistry at King's College, London and a historian of science, as a result of an announcement put in *Chemistry in Britain* in August 1974. The first meeting of the group was held at King's College in March 1975, followed by a reception. While the history of the Historical Group is not without interest, it is felt that a meeting about the social and scientific changes in chemistry since 1975 would be more attractive to a broader group of chemists. The meeting will consider the recent history of the main branches of chemistry (inorganic, physical, organic and analytical) alongside the changing role of women in chemistry and the development of green chemistry. The speakers are drawn from the ranks of past presidents of the RSC and leading textbook authors. It should thus prove to be a landmark event in the history of the Historical Group. Titles of talks will be available nearer the time. For more information please visit:

https://www.rsc.org/events/detail/82723/fifty-years-of-chemistry-celebrating-the-50th-anniversary-of-the-rsc-historical-group

Programme

10:00: Coffee and tea

Session One (chair: John Nicholson)

10.30: Welcome from John Nicholson, Chair of the Historical Group

10.45: History of the Historical Group, 1975-2025 - Peter Morris

11.30: Women in Chemistry - Lesley Yellowlees

12.15: Lunch (not provided)

Session Two (chair: Anna Simmons)

1.30: Inorganic Chemistry - Gill Reid

2.00: Organic Chemistry - Jonathan Clayden

2.30: Physical Chemistry - Peter Atkins

3.00 Tea and coffee

Session Three (chair: Peter Morris)

3.30: Analytical Chemistry - James Barker

4.00: Chemistry, the Environment and Sustainability - Keith Smith

4.30: Closing remarks by John Nicholson

4.45: Meeting ends

To book please email Mike Leggett, Historical Group Secretary, directly at leggett189@btinternet.com, giving your name, email address and any special requirements. The event is free of charge. Coffee and tea will be available, but lunch is not included, although there are plenty of cafes nearby in Piccadilly and adjoining streets.

Chemists as Politicians

This one-day in-person meeting organised by the Historical Group will take place on **Friday 16 October 2026**, 10.00-16:45, at Burlington House, Piccadilly, London W1J 0BA. The theme of the meeting is chemists who then became politicians (mostly MPs) rather than chemistry and politics which is a broader topic. The first half of the meeting will include talks given by historians on Lyon Playfair, Henry Roscoe, Stafford Cripps and Margaret Thatcher. The second half will be talks given by living chemists who became

MPs. This is still provisional, but the group is hoping that Brian Iddon (Labour) and Julian Huppert (Liberal Democrat) will speak and we are seeking a Conservative counterpart. The meeting will end with a talk about being a political advisor to the RSC by Stephen Benn, Viscount Stansgate. The meeting will appear on the RSC Events database after the conclusion of the Fifty Years of Chemistry meeting in March. As is customary, the event will be free of charge. Coffee and tea will be available, but lunch is not included, although there are plenty of cafes nearby in Piccadilly and adjoining streets.

Online Lectures

At the time of going to press, three online lectures have been arranged for 2026, taking place as usual on the third Tuesday of each month at 2 pm. In 2026 talks will be presented by Alice Halman, Peter Morris and Alan Dronsfield. The lectures are presented on the RSC Zoom Platform at 2 pm. Please start to log on at **2 pm sharp**. Look out for the Zoom links in the e-alerts circulated by the RSC on behalf of the Historical Group.

NEWS FROM THE RSC LIBRARY

HISTORY OF BURLINGTON HOUSE

The new edition of the RSC's booklet about the History of Burlington House and the Royal Society of Chemistry's presence is now available. Visitors to Burlington House may pick up a hard copy and it is available online at:

https://online.flippingbook.com/view/534146347/14/

The RSC library has a range of other booklets available to download on topics including its Historical Collection and past presidents of the Chemical Society and Royal Society of Chemistry. For more information on these and all library services see:

https://www.rsc.org/publishing/product-information/library-catalogue

SHORT NOTICES

Edgar Anderson (1940-2025)

Edgar Anderson, member of the Historical Group and Professor Emeritus of Organic Chemistry at UCL, died in August 2025 at the age of eighty-five. He was noted for his work in conformational organic chemistry. Members may remember Edgar's piping in of the haggis at the end of the meeting of 9

February 2011 celebrating the erection of a blue plaque commemorating Sir William Ramsay (1852-1916, Nobel Prize for Chemistry, 1904). Ramsay had been Professor of Chemistry at UCL from 1887 to 1913, and, like Edgar, was a Scot (*RSCHG Newsletter*, Summer 2011, 60, 36-7). While at UCL, Edgar and a colleague, John Callanan, applied their chemical knowledge to wine, establishing "Bentham Fine Chemicals"; they bought up good wine at auctions and sold it on to UCL colleagues at attractively low prices. Edgar was a sociable and generous person and his involvement and presence enhanced UCL events, especially those of the Professors' Dining Club and the Crabtree Foundation. He will be greatly missed.

Michael Jewess

MISSING ENTONOX FILM - APPEAL FOR ASSISTANCE

In December 1994 a meeting at the Royal Society of Medicine (RSM) was held to mark 150 years of nitrous oxide (N_2O) anaesthesia*. It was jointly organised by the History of Anaesthesia Society and the Anaesthetics Section of the RSM. One of the speakers was a member of the British Oxygen Company (BOC) who provided sponsorship. They also lent a film showing the injection of oxygen into liquid N_2O, in a quartz container, to create Entonox. This historic film was made by the British Oxygen Company following experimental work.

Dr Michael Tunstall as a trainee anaesthetist had suggested the idea to BOC in the late 1950s, citing the Poynting effect. Arthur Bracken who was the Chief Chemist at BOC at the time, wrote back admitting that no one had actually tried mixing the gases at a higher pressure. Six months later, Dr J.W. Haworth (BOC) succeeded in dissolving oxygen into liquid N_2O to make the 50-50% mixture, also cylinders of 60-40% and 70-30% nitrous oxide and oxygen, all at a total pressure of 2000 psi. I think they were more surprised than anyone, and they only formally demonstrated the solvent effect of high-pressure oxygen on liquid gases four years later.

I am now trying to find that historic film and have drawn a blank. Bracken and Haworth are the two chemists who were involved. Can anyone provide further information about them and/or the film? Considering the importance of Entonox since 1961 for the relief of pain in childbirth, being carried in ambulances for casualties and used in A&E departments for painful procedures, it will be good to find the film.

If you can help please contact Adrian Padfield on padfieldadrian@gmail.com

*Reference: *Proceedings of the History of Anaesthesia Society,* Vol. **16**, page 9 *et seq.* Available from https://www.histansoc.org.uk/society/proceedings

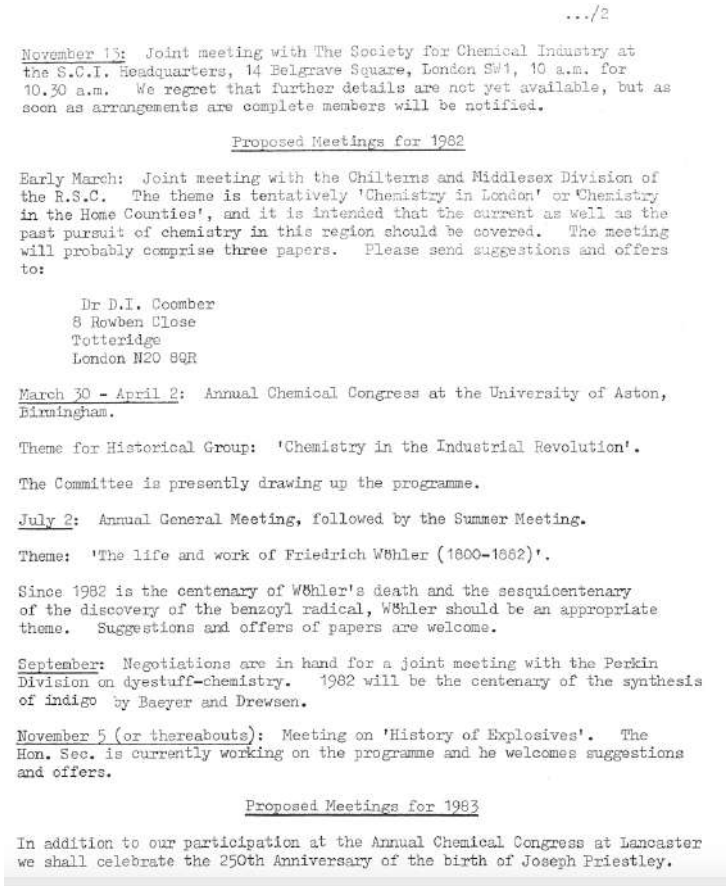
SHORT ESSAYS

A Brief History of the Historical Group Newsletter

The first Historical Group (HG) newsletter appeared in June 1981 and, starting as four typewritten A4 sheets, it became an A5 booklet with a cover two years later. The first summaries of past talks also appeared in this fourth issue. The talks were briefly hived off in mid-1980s to a separate booklet, but then returned to the main newsletter. The early newsletters covered the organisation of the group (such as membership figures), the meetings of the group and other history of chemistry meetings, recent publications and news of the history of chemistry community elsewhere, for example the development of the Center for the History of Chemistry in Philadelphia. Initially the newsletter was produced by Colin Russell as the Chair of the HG (in the form of a letter and typed by his secretary Pat Dixon), but when he stepped down in 1982, it was taken over by John Shorter as the Secretary. With the burden of other duties (such as the organisation of meetings and membership matters), it was difficult for Shorter to spend much time on developing it. When the summaries of the talks were included in the newsletter, it was typically about twenty pages long (as in January 1985).

The newsletter first started to take something like its present format when Peter Reed took over as the editor in 1988, but when he stepped down in 1994, it was still only twenty-seven pages long (July 1994). After a short period of caretaker editors, Peter Morris took over in 1996 and the newsletter accepted papers for the first time. His proudest achievement was the special issue dedicated to Alec Campbell in 2000, which was fifty-six pages long. He stepped down in the following year to become editor of the SHAC journal *Ambix*. A high standard was maintained by his immediate successors Katherine Watson (2001-2006) and Viviane Quirke (2006-2011) and they were able to obtain papers from external authors (Morris had written much of the content himself). The modern era of the newsletter began when Anna Simmons took over in 2011 and under her editorship, it has become a bona fide history of chemistry journal covering a wide range of events and historical topics with a consistent length of sixty-four pages. In 2024 a new

section “Two books that markedly influenced my chemical career” was introduced and the newsletter continues to showcase original research in the history of chemistry.



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November 13: Joint meeting with The Society for Chemical Industry at the S.C.I. Headquarters, 14 Belgrave Square, London SW1, 10 a.m. for 10.30 a.m. We regret that further details are not yet available, but as soon as arrangements are complete members will be notified.

Proposed Meetings for 1982

Early March: Joint meeting with the Chilterns and Middlesex Division of the R.S.C. The theme is tentatively 'Chemistry in London' or 'Chemistry in the Home Counties', and it is intended that the current as well as the past pursuit of chemistry in this region should be covered. The meeting will probably comprise three papers. Please send suggestions and offers to:

Dr D.I. Coomber
8 Rowben Close
Totteridge
London N20 8QR

March 30 - April 2: Annual Chemical Congress at the University of Aston, Birmingham.

Theme for Historical Group: 'Chemistry in the Industrial Revolution'.

The Committee is presently drawing up the programme.

July 2: Annual General Meeting, followed by the Summer Meeting.

Theme: 'The life and work of Friedrich Wöhler (1800-1882)'.

Since 1982 is the centenary of Wöhler's death and the sesquicentenary of the discovery of the benzoyl radical, Wöhler should be an appropriate theme. Suggestions and offers of papers are welcome.

September: Negotiations are in hand for a joint meeting with the Perkin Division on dyestuff-chemistry. 1982 will be the centenary of the synthesis of indigo by Baeyer and Drewsen.

November 5 (or thereabouts): Meeting on 'History of Explosives'. The Hon. Sec. is currently working on the programme and he welcomes suggestions and offers.

Proposed Meetings for 1983

In addition to our participation at the Annual Chemical Congress at Lancaster we shall celebrate the 250th Anniversary of the birth of Joseph Priestley.

Figure 1: Historical Group Newsletter No. 1, June 1981 page 2.

This has been extracted (and adapted) from Peter J.T. Morris, *The History of the RSC Historical Group*, which will appear later this year.

Two Books that Markedly Influenced My Chemical Career

In this section we invite RSC Historical Group members to share their thoughts on two books that have influenced their careers in chemistry. In this article, Historical Group Chair, John Nicholson reflects on *Nuffield Advanced Science: Chemistry Students' Book* and Courtenay Phillips and Bob Williams' classic undergraduate textbook *Inorganic Chemistry*. If you would like to contribute another article to this series, please get in touch via historicalgroup.newsletter@gmail.com

Nuffield Advanced Science: Chemistry. Students' Book II. Topics 13-19 (London: Longman Group Ltd, 1970) – (Nuffield).

C.S.G. Phillips and R.J.P. Williams, *Inorganic Chemistry*, 2 vols. (Oxford: Oxford University Press, 1965) – (Phillips and Williams).

These two books were important to me in my path to becoming a professional chemist. In the first case (Nuffield), it was significant in drawing me into studying for a degree in chemistry, so had a major impact on my life. In the second case (Phillips and Williams), it covered topics such as co-ordination chemistry, a subject that has been important in my subsequent research and featured in several of my publications.

For reasons that are not entirely clear to me now, I came to chemistry relatively late. Unlike many chemists, I never had a chemistry set. Neither did I acquire chemicals from a local pharmacist to make new substances at home. As a result, I missed out on being attracted to the subject at a young age. Ironically, my late twin brother had a chemistry set. It was a present on our tenth birthday; for the same birthday, I received a conjuring set, perhaps a different sort of magic.

My father enjoyed chemistry at school, and had obtained a high grade in his School Certificate exam. It was therefore with great delight that he supervised experiments with my brother's chemistry set, which I used to watch. But despite my father's enthusiasm, I did not catch the bug. The colour changes did not appeal to me very much, and I found the similarity of names for identical looking white powders confusing (for example sulfate and sulfite).

In 1966, I passed the eleven plus and went to grammar school. There, we began to study all three sciences as separate subjects, with a double lesson of chemistry on Thursday afternoons. I found myself enjoying the subject, and in the initial set of summer examinations at the end of the first year, I came top in chemistry. But chemistry was only one subject among many; I had a

broad and exciting curriculum that included Russian, and English language and literature, which I particularly enjoyed. Among the sciences, I found biology consistently interesting, and biology was in my family: my grandfather had been a doctor; my uncle was a dentist; and my cousin studied biochemistry at university.

So, I went through school enjoying chemistry well enough but not thinking about it in terms of a career. The main reason I took it for A Level was to support biology but, nonetheless, I continued to do well in it throughout the sixth form.

I was especially fortunate in that the chemistry course I took was the one pioneered by the Nuffield Foundation. That brings me onto the first influential book of my career, the *Nuffield Students' Book II*. This book covers essentially the second year of the Nuffield A Level chemistry course and I took it in the academic year 1972-1973. The first year had been covered by Book I and consisted of twelve topics. Book II covered a further seven topics, with subjects such as organic chemistry, reaction rates, equilibria, and d- and p-block elements.

The introduction to *Book I* states that it is "… not a textbook, not a background book, not a book of data – this book has been deliberately left in many ways incomplete". The same could be said of my choice, *Book II*. It, too, might be considered incomplete, like an outline map with starting points to build up a picture of chemistry. So, its nature was unusual. It was designed for interaction, not passive reading. Plus, it led to ideas about topics such as the driving force for chemical change and the likely path of such processes. The emphasis was on understanding rather than "preps and props" as in more conventional courses.

The book also included some especially exciting pieces of chemistry. There was, for example, a lot of biological chemistry, such as on the role of metal ions in living systems and on the structure of proteins. As part of the latter, we hydrolysed wool and identified the amino acids obtained. The method involved what was essentially a repeat of the classic work of Archer J.P. Martin and Richard L.M. Synge from thirty years previously, using partition chromatography. It seems a pity that this is no longer in the A Level course, and I wonder why not. The amino acid spots were developed with a spray of ninhydrin, which formed attractive pink colours. Perhaps these days there are health and safety concerns about ninhydrin?

I also recall enjoying the electrochemistry topic, and my first experience of co-ordination chemistry. In both cases, I remember vividly the initial experiments in each topic, as directed by the appropriate sections of *Book II.* In the first case, we put a piece of zinc into copper sulfate solution, and watched as a bright coating of copper appeared on the surface of the zinc and the blue colour of the copper sulfate faded. In the second case, we poured aqueous ammonia into copper sulfate solution and formed the striking royal blue copper tetra-amine complex. Unlike my ten-year old self, in my sixth form incarnation, I found these changes intriguing. This may have been because the observations were accompanied by an explanation in each case, and I liked being able to understand what I had seen.

As a result of working through *Book II*, I realised that chemistry could lead to a significant understanding of biology and I enjoyed that. I had also met many purely chemical topics that I found really interesting. I had made new compounds, including one, the pesticide DDT, in a multi-stage organic synthesis. I had also done my own guided experiments and understood the underlying chemistry. Well before we finished the final topic in the book, I knew that this was what I wanted to do for my career; that chemistry not biology was my future. I cannot imagine a book being more influential than that.

Despite this, early in the autumn of the upper sixth, when it came time to apply to university, I was still preoccupied with biology as a career. Consequently, I applied for a variety of degrees in biological sciences and, in due course, was offered a place to study physiology at the former Chelsea College, then part of the University of London.

I had another stroke of good fortune. My school encouraged us to consider polytechnics by way of insurance in case university applications did not work out. So, I wrote off to various polytechnics. A number offered biology degrees but one, Kingston, did not. Instead they had a degree in applied chemistry which included final year options in specialist subjects, one of which was biochemistry. I found this possibility strongly appealing, and I duly applied for a place on the degree programme. Shortly after applying, I was interviewed and accepted. It all seemed very exciting and led to me turning down my offer from Chelsea College.

As I went through my degree, I got more and more committed to chemistry as a whole, and my interest in biological aspects faded. So much so that I did not take the biochemistry option in my final year, but instead took polymer

chemistry. That was partly because of the amount of physical and organic chemistry involved, but also because I liked the small materials science component. The choice had a modest influence on my career, as polymers were the subject of a short, introductory book I wrote for the RSC around 1990, and which ran to five editions [1].

En route to my BSc, I came across my second influential book, *Inorganic Chemistry* by Phillips and Williams. This was important to me as I studied for the Part 1 exams of my degree course, around Christmas 1975. In particular, I liked the way it covered the key topics of co-ordination chemistry and ligand field theory. It was influential over the longer term, because co-ordination chemistry ended up being an important part of my PhD research and the subject of my first paper [2]. It has also continued to be a part of my subsequent work in materials chemistry. However, unlike the aspects covered by Phillips and Williams, my co-ordination chemistry has involved only main group elements, namely tin, calcium, zinc and aluminium. As a result, I have only worked with essentially colourless complexes, though a few of my early tin-based co-ordination compounds were pale yellow.

In considering Phillips and Williams, it is worth remembering how rapidly inorganic chemistry had changed in a relatively short time. Around 1950, it had low academic status, with just one professor of inorganic chemistry in the UK, Professor H.V.A. Briscoe at Imperial College. There was little in the way of research, and its status was described as *tombstone chemistry with a dash of sulfuric acid*.

Following the discovery of ferrocene [3] and Geoffrey Wilkinson *et al*.'s classic work to explain its structure [4], things changed quickly. Wilkinson moved to the Chair in Inorganic Chemistry at Imperial College in January 1956, where he began his Nobel Prize-winning work on transition metal organometallic chemistry. Across London, at UCL, Ronald Nyholm was promoted to a Chair of Chemistry (not specifically Inorganic Chemistry), and famously took as the title of his inaugural lecture "The Renaissance of Inorganic Chemistry". [5] The subject had come alive in a few short years, and not only because of developments in transition metal chemistry. Also important were the growth in co-ordination chemistry and the application of ligand field theory to explain the bonding, optical and magnetic properties of the new compounds.

It took a while for the textbooks to catch up. Older books tended to be more or less collections of facts, with little theoretical underpinning to hold them

together. This changed in 1962, when the first edition of Cotton and Wilkinson's classic textbook appeared [6]. It dealt with modern theories and gave a basis to explain the new observations that were filling the contemporary research literature.

Then, in 1965, came Phillips and Williams. It had similar aims, and was a non-traditional book that covered the same new topics, with a strong foundation of ligand field theory. Perversely, I found it more accessible than Cotton and Wilkinson. There is some doubt about which was the more innovative of the two textbooks. In his autobiography, Peter Day wrote "When the book appeared finally, in two volumes from the Oxford University Press, it proved a major influence on emphasis and style of inorganic chemistry teaching for years after, though it never enjoyed the sales or fame achieved by another contemporary take on the same subject (though a much more conventional one) by F. Albert Cotton and Geoffrey Wilkinson". [7]

Some years after its publication, one of the authors, Robert Williams, wrote:

> The book was novel, concentrating on intellect-based discussion of as much modern theory as possible (and more than most students could stomach) followed by correlation of data on inorganic compounds in various graphs. …. It was not a highly successful textbook for undergraduates worldwide as it was too difficult and unrelated to practical concerns. [8]

So, after forty years, he was not very positive about his efforts. But I liked it; at least, I liked the bits I needed. I got my "practical concerns" from the much more conventional book by Heslop and Robinson [9], having learnt early in my degree to cherry-pick information from a variety of sources. I was happy to use whichever book I needed for specific topics, and to be selective about how I read textbooks. That meant that I was content to use Phillips and Williams for the key topics of modern theory and I definitely got a lot out of it. I still feel that I made a good choice, and the book remains my preferred textbook in the subject.

There is a postscript to my reflections on these influential chemistry books. During my time as a professional chemist, I met authors of both books. *Nuffield Book II* was written by a project team of twelve educators, one of whom was Bob Jones. Bob had a strong interest in the history of chemistry and thirty years ago, in retirement, joined the RSC Historical Group committee. He and I also served together on RSC Council around the same time, and I got to know him reasonably well. He had interesting ideas about

teaching and the history of chemistry, noting that those concepts that had been adopted into chemistry with the greatest difficulty in the past are typically those that cause the most problems for students.

A little later, I also met R.J.P. Williams. I was on the committee of the RSC Chilterns and Middlesex Section and one of the evening lectures that we organised in the late 1990s was on bio-inorganic chemistry and given by him at King's College, London. Afterwards, a group of us took him to dinner at the former "Lugger Fish Restaurant" in The Strand. He proved to be engaging company, with a fund of interesting anecdotes about intellectual life in Oxford.

I read my two influential books around fifty years ago and am still grateful for their impact on my career and, indeed, my life. Meeting the authors was a bonus, confirming that I had found my true home among the ranks of professional chemists. My route into chemistry may have been slightly unconventional but I made it and have loved my time in the subject. I am pleased to acknowledge the part played by these books. *Nuffield Book II* opened the door to a degree in chemistry; Phillips and Williams gave clarity to important theoretical topics. I cannot overstate my regard for these two books and remembering them for this article has been a joy.

References

1. J.W. Nicholson, *The Chemistry of Polymers* 5th edition (Cambridge: Royal Society of Chemistry, 2017).
2. J.W. Nicholson, J.A. Douek and A.J. Crowe, *J. Organomet. Chem.*, 1981, **219**, 309.
3. T.J. Kealy and P.L. Pauson, *Nature*, 1951, **168** (4285), 1039; S.A. Miller, J.A. Tebboth and J.F. Tremaine, *J. Chem. Soc.,* 1952, 632.
4. G. Wilkinson, M. Rosenblum, M.C. Whiting and R.B. Woodward, *J. Am. Chem. Soc.,* 1952, **74**, 2125.
5. R.S. Nyholm, *J. Chem. Ed.,* 1957, **34**(4), 166.
6. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry* (New York: Interscience Publishers (John Wiley and Sons),1962).
7. P. Day, *On the Cucumber Tree* (Glasgow: The Grimsay Press, 2012), 40.
8. Robert J.P. Williams, "Recent Times, 1945-2005: A School of World Renown", in *Chemistry at Oxford: A History from 1600 to 2005.* Eds. Robert J.P. Williams, Allan Chapman and John S. Rowlinson (Cambridge: RSC Publishing, 2009), 195-291, on 221.
9. R.B. Heslop and P.L. Robinson, *Inorganic Chemistry* (Amsterdam: Elsevier, 1967).

John Nicholson

Methylene Blue and Paul Ehrlich's Magic Bullets: More Than Even He Imagined?

Paul Ehrlich holds a major place in the history of chemistry in medicine; he was the first to synthesise a treatment in the laboratory rather than refining it from nature. In 1910, he developed the first effective drug treatment for syphilis, the organo-arsenic compound Salvarsan [1]. Previously, most medicines came from nature (*e.g.* digoxin from foxgloves to treat heart failure; quinine from cinchona tree bark to fight malaria; morphine from poppies to relieve pain). He proposed his 'magic bullet' theory, that certain chemicals could specifically target microbes or tumours without harming patients' healthy cells.

Though Ehrlich trained as a medical student, his wide range of interests included a precocious knowledge of structural chemistry and a fascination with dyes as probes of cellular activity. One such dye, possibly his favourite, was methylene blue (1). This was widely available using Heinrich Caro's 1876 synthesis involving the oxidation of 4-(dimethylamino)aniline with iron(III) chloride [2]. This selectively stained the plasmodia parasites which cause malaria. It occurred to Ehrlich that a sufficient dose might poison the infective agent in concentrations that were non-toxic to the human host. This proved correct. He discovered that "under the administration of methylene blue, the attacks of fever ceased in the course of the first few days and the plasmodia disappeared from the blood after a week at the latest". In pursuing his studies with this dyestuff, Ehrlich noticed its affinity with nerves. This provoked a two-pronged investigation. Firstly, recognising that the sensation of pain was intimately tied up with nerve transmission, he tried its effectiveness against "rheumatic afflictions of joints, muscles and tendons", and encouragingly observed a pain-relieving effect. Secondly, he speculated that it might affect the nerves in the brain itself, possibly calming patients experiencing psychosis and relieving hallucinations. This appeared not to be so. In 1890 he decided to focus his research elsewhere, including treatments for tuberculosis [1].

About ten years later an Italian physician, Peter Bodoni, was using methylene blue to monitor kidney function in psychiatric patients. In an account almost devoid of quantitative data he reported that in patients who were "afflicted with excitation and delirium.....methylene blue exerted a calming effect sometimes persisting several days" [3]. Perhaps understandably, given the quality of this account, there are only two further reports of its use in psychiatry over the next eighty years, in 1938 and 1964.

Its place in psychiatry was re-examined in the 1980s by G.J. Naylor, working at the Royal Dundee Liff Hospital. He examined the effects of adding methylene blue to conventional treatments in people suffering from bipolar disorder (manic depression) [4]. As methylene blue turns one's urine various shades of blue, the usual placebo capsules were not an option. He used a low dose of 15 mg/day as his placebo, sufficient to change the colour of urine without the significant pharmacological effect he hoped for from the treatment dose of 300 mg/day. Indeed, this group showed the greater degree of recovery.

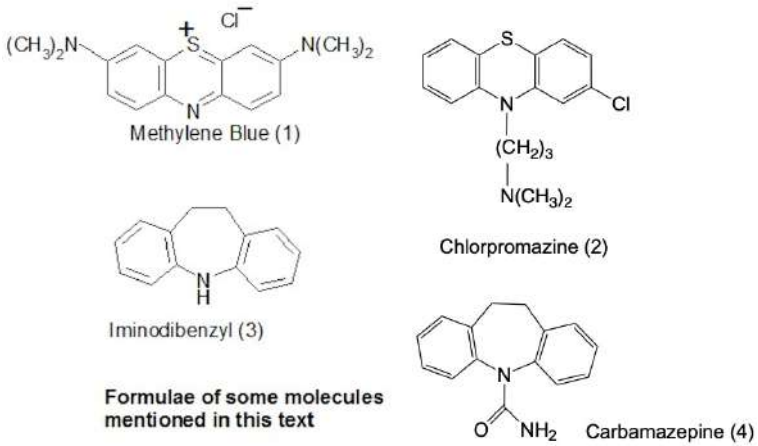
This and more recent studies found that while methylene blue didn't sedate patients experiencing mania, it did ameliorate symptoms of depression when combined with conventional lithium therapy, even at Naylor's 'placebo' dose of 15 mg/day, and was of some assistance for those with incomplete responses to conventional anti-psychotic therapy.

We concluded our 1999 article by commenting:

> Despite these interesting findings, the benefits of methylene blue therapy have not been great enough to lead to its regular use today. However, chemically, methylene blue is a phenothiazine and is of the same family as chlorpromazine (2), introduced in 1952. This was the first effective treatment for schizophrenia and manic excitement, and revolutionised the practice of psychiatry. One can only wonder what Ehrlich might have found if he had noted the benefits of methylene blue on depression or psychosis and extended his investigations to other similar structures. [5].

Well, investigations over the last quarter century have revealed some of this potential, although whether this will amount to further 'magic bullets' remains to be seen. It turns out that methylene blue has a wide range of biological actions. Structurally, it is also similar to iminodibenzyl (3), a chemical close to tricyclic antidepressants and carbamazepine (4). (Carbamazepine has mood stabilising properties as well as being an anticonvulsant.) However, methylene blue has a wide range of other actions.

These include modulation of redox processes and mitochondrial functions; inhibition of nitric oxide synthase, guanylate cyclase, and other signal transduction systems; blockade of the GABA-A receptor; inhibition of monoamine oxidase A; inhibition of tau protein aggregation; and antiviral, antibacterial, as well as anti-inflammatory effects [6].



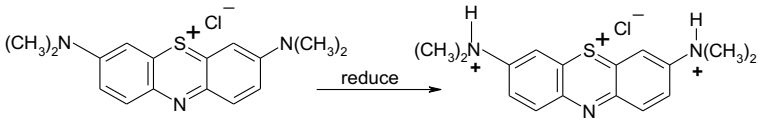
Formulae of some molecules mentioned in this text

Some tantalising animal studies suggest methylene blue may have significant protective effects when administered after traumatic brain injury, limiting the extent of resulting damage. Others suggest it can reduce the damage caused by interruption of blood supply to the brain – a model of stroke. These have yet to be explored in humans.

But perhaps of greatest interest are studies in the sadly all too common condition of Alzheimer's disease. This is characterized by an accumulation of plaques, consisting of amyloid protein between neurons, and neurofibrillary tangles within neurons, although it is not clear yet whether these are the cause or a consequence of the condition. In healthy neurons, microtubules have a critical role in transporting nutrients within the cell, and tau protein stabilises their structure. In Alzheimer's disease, tau becomes abnormally chemically altered, detaches from microtubules, and clumps together, disrupting the cells' nutrient pathways and causing cell death. These can be seen as neurofibrillary tangles.

It appears, in animal and cell culture models, that methylene blue and its derivatives stabilise tau, reducing the development of neurofibrillary tangles.

It may also reduce the accumulation of amyloid protein that results in plaques. An early (2015) trial in 321 people suffering from mild to moderate Alzheimer's disease was led by Claude Wislink in Aberdeen, with predominantly UK collaborators [7]. They found a modest but significant benefit of a daily dose of 138 mg (but none at 228 mg /day) after twenty-four weeks of treatment, which persisted at fifty weeks. They suggested that the lack of effect at the higher dose was related to absorption problems of the higher dose. Not all further trials have supported this finding, but, as at 1 October 2025, the UK Medicines and Healthcare products Regulatory Agency is considering the suitability of hydromethylthionine mesylate (5) as a potential oral treatment for Alzheimer's disease, although it requires some further information before a final decision can be reached [8] **.**



Scheme 1

Even if this or a similar methylene blue-related compound does reach clinical practice, it may not amount to another magic bullet curing the condition – but bullets can wound and slow down an assailant, and with such an intractable foe as Alzheimer's disease, every advance is one worth making.

This is an updated version of an article that appeared in *Education in Chemistry* in 1999 [5]. A recent review on the clinical effectiveness and prospects of methylene blue therapy is available as a free download [9].

References

1. Wikipedia provides a good account of Ehrlich's life and work: https://en.wikipedia.org/wiki/Paul_Ehrlich
2. F. Sanchez-Viesca and R. Gomez, *Earthline J. Chem. Sci.,* 2021, **6**(2), 209-214.
3. P. Bodoni, (*in) Semaine Medicale*, 1899, **7**, 56.

4. G.J. Naylor, B. Martin, S.E. Hopwood and Y. Watson, *Biol. Psychiatry*, 1986, **21**(10), 265-269.
5. A. Dronsfield, P. Ellis and T.M. Brown, *Educ. Chem*., 1999, **36**, 112.
6. M. Alda, *CNS Drugs*, 2019 , **33**, 719-725.
7. C.M. Wischik, R.T Staff, D.J Wischik, P. Bentham, A.D. Murray and J.M. Storey, *J. Alzheimer's Disease*, 2015, **44**, 705-720.
8. TauRx Pharmaceutics, *FirstWord Pharma*, 9 April 2025. Available at https://firstwordpharma.com/story/5948587. Recently updated at https://taurx.com/news/industry-news/mhra-response-to-hmtm-marketing-authorisation-application (1 Oct 2025).
9. A. Seitkazina, J-K. Yang and S. Kim, *Precision and Future Medicine*, 2022, **64**, 193-208. Available at https://www.pfmjournal.org/journal/view.php?number=132.
10. For methylene blue to become biologically active, it must be converted from its oxidised, blue form to its reduced, colourless form, hydromethylthionine (Scheme 1). Treating patients with this compound directly addresses the inconsistent absorption issues of the older methylene blue precursor.

Alan Dronsfield and Pete Ellis
(Pete Ellis is a retired professor of psychiatry)

Chemicals Activity at Staveley Works: From Coal and Iron, to Coal Tar Distillation and Electrochemical products, to Benzene Refinery products

Introduction

Having read the illuminating two-page article by Philip Ball "Benzene's 200-year Legacy of Transformation" published in *Chemistry World* in July 2025 [1], daydreams took over as I recalled first using benzene to make benzene sulphonate in 1958, whilst employed as an apprentice research chemist by Staveley Iron & Chemical Company Limited. A few years later during 1967-1968, as a senior technical assistant working for Staveley Chemicals Limited (SCL), I became involved in the commissioning of a new BTC plant, perhaps more appropriately a new refinery complex producing benzene, toluene, cyclohexane.

Historical Background

Richard Barrow (1787-1865) is generally regarded as the founder of modern iron making at Staveley, near Chesterfield in north-east Derbyshire. He exploited local ironstone quarried from land leased from the Duke of Devonshire on the outskirts of the village and expanded into coal mining. In 1863 the Staveley Coal & Iron Co. Ltd. was registered with Richard as Chairman. In 1905 the Staveley Coal & Iron Co. Ltd. opened a new 172 acre site to build new blast furnaces and coke ovens. This was adjacent to their existing site for what was destined to become known as Devonshire Works. In 1912 it moved into chemical production, initially from by-products available from coal tar distillation [2].

By 1951, the aftermath of the iron and steel industry nationalisation was undoubtedly a period of inertia and decline. Relatively little, by way of investment, had been spent at Devonshire Works which was inevitably nearing the end of its life expectancy, particularly as inland blast furnace plants were in decline due to adverse economic factors. Additionally, the market for foundry iron was deteriorating and the chemical plants were outdated. Having acquired Staveley Iron & Chemical Co. Ltd., which for many years had been an arch-rival of Stanton Ironworks Co. Ltd., Stewarts & Lloyds Ltd. had the opportunity to rationalise its productive iron capacity and planned to close the uneconomic blast furnaces and coke ovens at Staveley. Stewarts and Lloyds' traditional business was the manufacturing of iron and steel tubes, with the company formed in 1903 through the merger of two major British iron and steel makers. Before the full merger, the individual companies, A & J Stewart & Menzies of Coatbridge, east of Glasgow, and Lloyd & Lloyd of Birmingham had roots in the production of steel for these tubes.

Closure of the blast furnaces would end the supply of cheap in-house electricity, thereby adversely affecting the economics of the two electrolytic processes, namely chlorine/sodium hydroxide and sodium chlorate. All the downstream chemical by-products would be lost due to the closure of the tar plant and coke ovens and the lead chamber sulphuric acid plants which relied on spent oxide from the coke ovens. Crucially, unless these gaps could be filled there would also be an inevitable social problem resulting from redundancies, with consequent political pressures.

The Finance Act 1964 ended the preferential treatment accorded to indigenously produced hydrocarbon oils in the form of lower excise duty (1s 3d per gallon), which caused many benzole refineries to become less profitable. This prompted the need for something radical on the part of the larger benzole producers such as British Steel Corporation (BSC) and the National Coal Board (NCB) if they were to remain economically viable and be able to compete favourably with the oil companies that had both the economies of scale and products of higher purity and consistency.

Stewarts & Lloyds (S&L) was planning to build a benzole refinery to process crude benzole from their Corby and Stanton coking plants, together with anything that could be purchased from either independent merchant coke producers or other steel companies. At the same time the National Coal Board (NCB) was also planning to build a new refinery to replace some of its old benzole refineries at former coking plants and collieries Avenue (Chesterfield), Glasshoughton (Wakefield), Manvers (Rotherham) and Smithy Wood (Sheffield).

Figure 1: The new refinery complex which produced benzene, toluene and cyclohexane (December 1968). This photograph shows all of the main chemical plant. The reformer is the tall structure immediately behind the fourth column when viewed from left to right and the Benfield Stripper is behind the first and third columns in the foreground.

Ultimately, a single, large benzole refinery incorporating the latest hydro-refining technology to produce high quality finished products, which would

also be capable of dealing with light oil feedstocks containing high sulphur and paraffinic impurities, was the obvious answer. Staveley Chemicals Ltd. was therefore, an innovative partnership owned primarily between Stewarts & Lloyds and the National Coal Board designed to address adverse changes in the business environment consequent to the change in the rate of excise duty.

BTC Complex

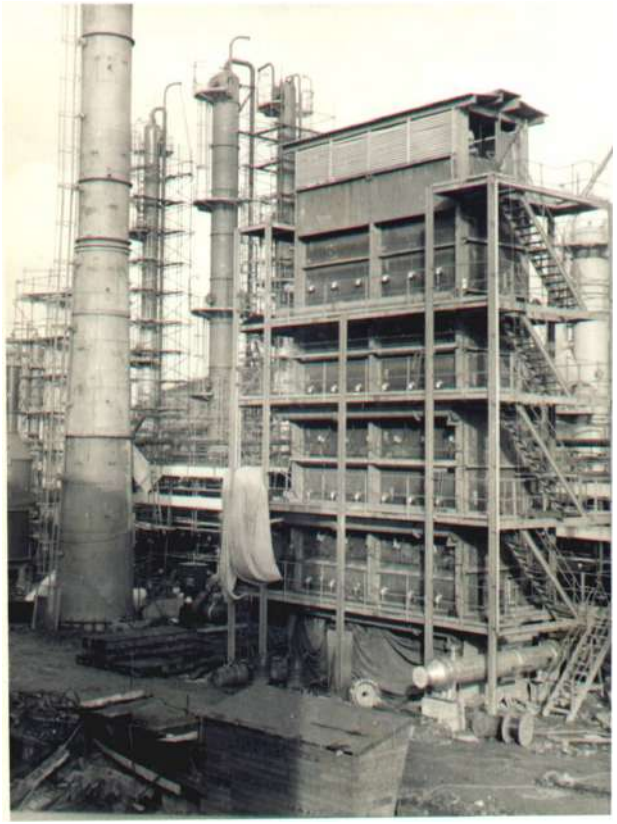


Figure 2: BTC Complex, ICI Selas Reformer (June 1967)

The benzole refinery had an annual throughput capacity of 24 million gallons of crude benzole and cost £3 million (roughly £78.6 million at May 2025 prices); it was commissioned in order to produce 80,000 tpa of high purity benzene, 6,000 tpa of toluene and 40,000 tpa of cyclohexane.

Construction work started in 1966 and commissioning began in 1967. L.H. Manderstam & Partners were the consulting engineers, and Badger Ltd was the main contractor. It consisted of three state-of-the-art chemical plants: a Selas hydrogen reformer, a Houdry Litol plant and an IFP Cyclohexane plant, plus ancillary facilities.

Reformer

The reformer utilised a process developed by ICI, and was built under licence from Selas. One of seven worldwide, it produced 6 million standard ft^3/day of hydrogen containing 5% methane. It operated at a temperature of 1,500 degrees Fahrenheit and a pressure of 400 psi.

Figure 3: BTC Complex, Benfield Stripper. Photograph taken from laboratory access (June 1967).

Initially, naphtha was used as feedstock but later changed to butane. It is a flammable complex liquid mixture of hydrocarbons, primarily derived from

the distillation of crude oil, containing various aliphatic, naphthenic, and aromatic hydrocarbons with carbon numbers typically ranging from C_5 to C_{12}.

Naphtha was fed into the reformer which reacted with an input of superheated steam that enabled the oxygen in the water to combine with the carbon in the naphtha to produce CO and CO_2 with consequential liberation of hydrogen.

A shift converter changed the CO to CO_2, and the CO_2 was removed in the Benfield stripper by absorption with KOH and vented to atmosphere. A methanator reduced the CO_2 to 10 ppm, producing a mixture of 95% hydrogen and 5% methane.

Litol Plant

The initial Houdry process was a catalytic cracking method for refining crude oil into gasoline. However, by the 1960s, a related Houdry Litol process was developed to purify crude light oil derived from coal carbonisation into high-purity benzene, a key component of crude benzole. The Litol plant was one of two in the world, the other sited near Baltimore in the USA and owned by the Bethlehem Steel Company, to process 80,000 tpa of parental crude benzole.

Parental crude benzole feedstock was produced by BSC Plants at Corby and Stanton and NCB plants at Avenue Works in Derbyshire, Manvers, Glasshoughton and Smithy Wood in Yorkshire and from Derwenthaugh, Fishburn and Monkton in the north east area. Closure of the Staveley blast furnaces complex in 1966 provided an ideal centrally located UK site for the new benzene refinery.

Crude benzole is derived from coal tar and typically contains:

(a) benzene (65-70%), toluene (10-13%) and mixed xylene isomers (4-6%)

(b) other aromatic hydrocarbons include dimethyl-benzene, trimethyl-benzene, ethyl-toluene.

(c) unsaturated compounds such as cyclopentadiene, styrene, and indene.

(d) aliphatic hydrocarbons such as pentane, hexane, heptane, decane and dodecane.

(e) sulphur impurities such as carbon disulfide and thiophene and saturated hydrocarbon impurities such as phenol, and pyridine.

Crude benzole was fed into the pre-fractionator to remove a heavy bottoms residue rich in biphenyl. The defronted overhead stream was then fed into the Litol reactor where it reacted with hydrogen under specific catalytic cracking conditions such that:

(a) all the sulphur compounds were converted to hydrogen sulphide;

(b) all the aliphatic compounds to butane and lighter hydrocarbons;

(c) all the xylenes and a controlled quantity of toluene, to benzene.

Benzene being a very stable aromatic molecule passed through the refining process unchanged.

Any unused hydrogen was recycled through a gas purification section incorporating a cryogenic ‘cold-box’.

The liquid stream from the reactor passed through four continuous distillation columns to produce benzene, toluene, recycled heavier ends and fuel gas. The H_2S flare was fixed at the top of the fuel gas column. The toluene tower overheads, containing mixed xylenes, were recycled back to the Litol reactor, via the pre-fractionator reflux drum, where further dealkylation produced more toluene and benzene.

Notably, the benzene derived from coal tar was sulphur-free and its purity surpassed that produced from petrochemical sources, as was the case with the toluene and cyclohexane products. In addition to crude benzole, the Litol plant was capable of processing similar feedstocks and when parental sources of crude benzole diminished, alternative feedstocks were obtained whenever available.

IFP Cyclohexane Plant

The plant used a process developed by the French Institute of Petroleum (IFP now IFPEN) to hydrogenate benzene to cyclohexane. One of three, the other two were at Lacq, France and Milan, Italy. It was the least complex of the three plants, and by far the easiest to operate. Benzene was fed into the reactor and was hydrogenated to cyclohexane using a Raney-nickel catalyst in liquid-phase. At start-up, this required the liquid process stream to be recycled back into the reactor in a continuous loop until the exit stream was 100% cyclohexane, at which time it was then diverted to the tank farm.

Demineralised Water Plant

The demineralised water plant, which used ion-exchange resins, was capable of achieving a water conductivity value of less than 2 μmhos/cm (2 μS/cm). This was absolutely essential to prevent corrosion in the high pressure boiler and the specialist stainless steel, high pressure heat exchanger.

Heating System

The Complex had its own dedicated boilers which generated 40,000 pounds lb/h of steam during normal operations but was dependent on the Works' central boilers for up to 5,000 lb/h of steam. Conversely, it supplied the Works with up to 20,000 lb/h of boiler feed water from the demineralised water plant. At 150 ft, the main stack from the heaters was the highest structure in the Complex.

Tank Farm

A tank farm provided over 3 million gallons of storage: 2 million for benzene, toluene and cyclohexane with the remainder for crude benzole and naphtha; each tank was surrounded by a bund wall in case of leakage or spillage. Incoming deliveries of feedstocks and outgoing deliveries of finished products (road or rail) were facilitated via a nearby associated railhead until the early 1970s but thereafter rail transportation had become so prohibitive that road transportation was used exclusively.

Manning and Operative Training

The specified manning level for the Complex was twenty operatives, with a minimum of five operatives on shift at any one time. However, senior management decided that, during the initial phase of operation, it would be prudent to have an additional technologist on each shift, a practice that continued throughout 1968. The fact that the Complex was a highly instrumented facility, in common with most petrochemical plants of that era, made such a relatively small number of personnel possible, whilst ensuring that a smooth flow of materials was maintained at all times.

Recruitment started during February 1967 and on 1 March 1967 a major training programme was launched for the senior plant operatives listed below:

Shift Supervisors – Ray Hallam, Albert Hudson, Derek Tomlinson (externally) and Peter Willock.

Shift Technologists – Edwin Berry, Brian Morley, Ron Presswood and Roy Thompson.

The training was provided by Dr Geoff Wells, Process Engineer who also had overall responsibility for commissioning the BTC Complex. The programme commenced with an initial five-week period of in-house training, assimilating the contents of the various technical and operating manuals. Classroom instruction was supplemented by periodic visits to an on-site scale model of the Complex, which cost around £2,000 and had been made specifically as a learning aid and partly in order to minimise construction costs. In terms of size, it was roughly the size of two table tennis tables joined together end-to-end.

Pre-Commissioning Period

Classroom training was followed by fourteen-weeks of on-the-job familiarisation training, during which time other plant operatives were given the opportunity to become conversant with some aspects of their respective roles. In particular all twenty-four operatives were engaged in loading the various catalysts into the Hydrogen reformer tubes, the Litol reactor, the Shift converter and the Methanator sequentially, which involved a considerable amount of manual heavy work over several consecutive days to complete at each location.

Later on, some of the technologists, carried out detailed line checking against the official engineering drawings throughout the entire installation, paying particular attention to the two thousand plus valves in order to ensure that each valve installed was the correct specified type, namely gate, ball, needle, etc. Also, where a block and bleed assembly was required it was checked that these had been installed and were complete and fit for purpose.

Towards the final stages, since I had previous experience in constructing and using pilot-scale ion-exchange resins, I commissioned the demineralised water plant and trained, one of my shift team to be able to operate it. After commissioning commenced I was also privileged to have started-up the cyclohexane plant overseen by a representative from the IFP process licensors. Similarly, Peter Willock had previous experience of using compressors and he commissioned the large high pressure compressors.

Immediately prior to start-up, it was agreed that a rolling continental shift pattern would be adopted in order to ensure round-the-clock coverage. Under this system, each twenty-four-hour day was divided into three standard eight-hour shifts (days, afternoons, night); the workforce was then organised into four separate teams which cycled through the different shifts in a prearranged sequence, with one team resting. In practice by mutual consensus, the day

shift was shortened to seven hours and the night shift extended to nine hours thus: days (07:00-14:00); afternoons (14:00-22:00); nights (22:00-07:00).

If an occasion occurred where someone did not turn-up for their shift then the individual he was replacing was obliged to work his shift and the Company guaranteed that a replacement was available for the next shift if necessary.

Having initially become a Licentiate of the Royal Institute of Chemistry in January 1964, it was a privilege, indeed a pleasure, to have had the opportunity to work on a state-of-the-art chemical production complex, especially in a supervisory role. For several decades, all of the chemical plants at Staveley Works had used outdated technology, but the commissioning of the BTC Complex was a defining moment in the history of Staveley Chemicals Ltd. that ushered in a series of other innovative plants, namely: 2,3 & 3, 4 dichloroanilines/diuron (1975), para-aminophenol (1978) and dithranol (1,8-dihydroxy-anthrone) (1984).

A Major Catastrophe

Unfortunately, soon after the onset of commissioning the BTC Complex, there was a disastrous fire at the Litol plant which started at about 13:40. Fortuitously, this coincided with the shift changeover, thereby ensuring that six extra operatives were on hand to assist with the inevitable crash shutdown which was achieved very successfully. The cause of the fire was traced to a major leak of flammable liquid from a block and bleed valve connected to the high pressure flash drum, which had not been properly closed by an operative. The spillage then spread rapidly to the charge heater, which was heated by naked flames, leading to the ignition of volatile gases that were evaporating from the liquid. Suffice to say, the plant sustained significant damage and was out of service for at least six-weeks whilst repairs were undertaken.

In order to bring the Complex back on stream, extensive and varied civil and engineering works were carried out. In particular re-wiring the electrical and instrumentation cables from the control room to the central overhead cable tray carrier and from this upwards or downwards where necessary. In spite of the disruption, the normal work schedule was adhered to throughout this period, with much of the time being taken up replacing the catalysts in the Litol reactor, shift converter and methanator and other routine housekeeping.

Although the Houdry Litol plant was adversely affected by various issues for several months after its initial start-up, sometimes necessitating a complete shutdown, these had all been resolved by the end of 1968. Thereafter, the whole Complex remained virtually problem-free until its eventual closure.

Health and Safety Precautions

The International Agency for Research on Cancer (IARC) first classified benzene as a human carcinogen in 1979 [3], specifically for causing leukaemia. In Great Britain, regulations prohibiting the importation, supply and use at work of benzene and substances containing benzene came into force on 1 January 1992 [4], the only exceptions being use in industrial processes and for the purposes of research, development and analysis. The UK also monitors benzene levels to assess compliance with national air quality objectives and the corresponding EU Air Quality Directive limit value.

The Complex had its own conventional locker room with separate clean and dirty sides. Outer protective clothing had to be worn at all times whilst on site. This consisted of a green, heavy-duty boiler suit, made from fire-resistant and antistatic material, antistatic heavy-duty Wellington boots and antistatic gloves, the latter being donned as necessary. Safety helmets and goggles (which could be worn over glasses) were mandatory outside the control room and ear defenders when necessary. Various types of gas mask and an impressive array of bronze hand tools were stored in the control room, for use as and when required.

For safety reasons, every single person that entered the Complex or its immediate surroundings had to report to the control room immediately on arrival, and again immediately prior to departure. On arrival, everybody had to either confirm that they were not carrying anything that might conceivably act as a source of ignition (e.g. smoking materials, ferrous metal objects), or hand over any offending items for the duration of their visit. During the shift period all meal and refreshment breaks were taken in the control room.

Later Developments and Closure

By 1971, Distillers Ltd. had been persuaded to build an adjacent carbon dioxide purification and liquefaction plant. Carbon dioxide off-gas from the Benfield stripper was then piped directly to it instead of venting to atmosphere, ending an undesirable and wasteful practice. Over time, in-house technical expertise, was able to increase the Litol plant capacity achieving throughputs exceeding 150% of design, some 125,000 tpa. As a result, the BTC Complex became Staveley Chemicals Ltd.'s main source of profit for most of the 1970s. The 1974 Flixborough disaster had a significant adverse impact by the loss of a 40,000 tons captive cyclohexane market. Thereafter, tonnage sales of cyclohexane were relatively small, although the surplus

benzene feedstock was successfully marketed elsewhere by Benzole Producers Ltd. In 1991 the cyclohexane plant was converted to a general purpose plant but was closed in 1995. The BTC Complex closed in 1996 and required extensive decontamination prior to demolition. Dismantlement and demolition commenced in 1999 and was completed in 2000.

References

1. Philip Ball, "Benzene's 200-Year Legacy of Transformation", *Chemistry World,* July 2025, **22**(7)*,* 24-25.
2. For the history of the site see Ronald V. Presswood, "Industrial Activity Around the Staveley Works Site", *NEDIAS Journal,* vol. **3**, June 2010.
3. IARC Monographs, Vols. 1-20, Supplement 1 (1979): "Chemicals and Industrial Processes Associated With Cancer in Humans".
4. UK Statutory Instrument 1991 No. 2431: "The Control of Substances Hazardous to Health (Amendment) Regulations 1991".

An earlier version of this article "Benzene's 200-Year Legacy of Transformation" appeared in the North East Derbyshire Industrial Archaeology Society (NEDIAS) Newsletter, August 2025, 6-11.

All photographs courtesy of Ken Bale, formerly of Staveley Chemicals Ltd. and reproduced with permission.

Ronald V. Presswood
Employed at Staveley Chemicals Ltd. (1956 -1993),
latterly as Commercial Development Manager

The Discovery of PFAS ('Forever Chemicals') in Biological Materials

The environmental and human impacts of numerous industrial chemicals have received considerable attention from historians of science and technology [1]. However, some important products have escaped attention. This is especially the case for the so-called Forever Chemicals, the extremely stable long-chain per- and polyfluoroalkylated compounds containing multiple carbon-fluorine bonds. They were manufactured on a large scale from around 1950 and are mainly associated with the first, and main, manufacturers, Minnesota Mining and Manufacturing (3M) and Du Pont in the United States. Other sites of manufacture include several European countries and Japan. These compounds are collectively referred to by the acronym PFAS. Because of their special

properties, notably resistance to breakdown, PFAS were used in a wide range of commercial and domestic products. As fire-suppressants they were employed in the formulation of tough, resilient aqueous film-forming foams supplied to military bases and firefighting departments at airports. When formulated with polyisocyanates, certain PFAS gave urethane (polyurethane) coatings. By the late 1970s, the per- and polyfluoro products were, as surface treatments, applied to a variety of other uses, including for protection of carpets, as well as for paper and packaging products.

Concerns regarding health effects were raised from around the year 2000, and most PFAS have been, or are being, phased out. Today it is believed that 98% of the entire population of the United States has PFAS in the blood, mainly from potable water as well as through skin contact. During recent years, legislators in the United States and Europe have been pushing for restrictions on the manufacture, use, and disposal of PFAS. Much of this is well documented, including through the media. Less well known is the manner in which academic research in the 1960s and 1970s that focused on (inorganic) fluoride in dentistry and human health led to the finding that PFAS were present in human blood.

The story begins in the early 1960s with the development of a diffusion technique for measuring fluoride in biological materials by Wallace David Armstrong, at the Department of Biochemistry, The Medical School, the University of Minnesota, and Leon Singer, at Minnesota's School of Dentistry. Their published results were questioned by Donald R. Taves, at the University of Rochester, New York State, who was interested in the impact of sodium fluoride introduced to the body by fluoridation on renal disease, and in methods for measuring serum fluoride at the levels required to perform the proper renal clearance studies. Taves argued that the fluoride content was far less than reported by Armstrong and Singer. In response, the two Minnesota researchers resorted to ashing, by combustion, which appeared to support their findings; unlike most previous investigators they had extended the time of combustion. They did not realise that in so doing they had brought about quantitative release of organic fluorine in biological material by its total decomposition, followed by conversion into the ionic form, fluoride (F^-). In 1968, Taves, through repeating the ashing method, explained the apparent anomalous results when he established that two forms of fluorine, fixed (organic) and what he called 'exchangeable' (ionic), existed in blood, and could be clearly distinguished. The organic fluorine content was calculated by subtracting fluoride, as analysed quantitatively *without* ashing, from total

fluoride. Taves considered that the source of the organic compound(s) he had isolated were large molecules, with a high fluorine content, not unlike the industrial perfluorocarbons. In 1975, Taves and his doctoral student Warren Guy isolated a major component from human blood, and believed that there were one or more perfluorocarbons in the blood of communities located beyond the sites of manufacture of PFAS. They decided tentatively on the basis of ^{19}F-NMR data supplied by NMR expert Wallace Siegfried Brey, at the University of Florida (Gainsville), that what they had isolated was likely a perfluoro acid, or a closely related compound.

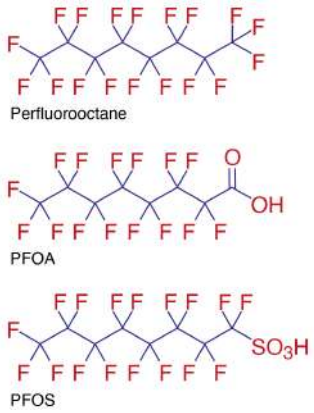


Figure 1: Perfluorooctane, PFOA (perfluorooctanic acid), and PFOS (perfluorooctane sulfonic acid)

Guy made contact with 3M requesting assistance in identification. This was not forthcoming. However, based on internal NMR analysis, 3M decided that the substance isolated by Taves and Guy was a derivative of perfluorooctane, namely perfluorooctane sulfonic acid (PFOS) (Figure 1). This was a matter of considerable concern because 3M was the primary manufacturer of PFOS. Evidence for the presence of PFAS in human blood led 3M to undertake intensive research into trace PFAS analysis by a number of techniques. These included conversion of the nonvolatile perfluoroalkanoic acid (PFOA) into a volatile derivative that was suited to analysis by gas chromatography (GC). This work benefited from earlier studies in organic fluorine analysis, and newly available instrumental techniques, in particular fluorine-specific electrodes, NMR, and GC using detectors suited to trace analysis of halogens [2].

As an aside, it is worth noting that in 1971 there was further evidence of the great stability and persistent environmental presence of organofluorines when James Lovelock at Reading used his electron capture detector (ECD) to identify by GC volatile fluorine compounds in the atmosphere. Lovelock suggested the use of these "industrial stable compounds as indicators of air movements and wind indicators" [3].

In the 1990s analysis of PFAS saw a tremendous leap forward with the application of high-pressure liquid chromatography (HPLC) for separation combined with tandem mass spectrometry (MS/MS) for detection. Quantitative measurement without the need for decomposition and derivatization became possible. The hyphenation of HPLC with MS required a means for overcoming the large pressure difference between the HPLC apparatus and the high vacuum MS spectrometer. This involved the introduction of new devices, and ultimately electrospray ionization. Though problems remained with selectivity and sensitivity the combined techniques provided evidence of widespread environmental exposure. Specific PFAS compounds in small volumes of blood were identified. Through the use of electronic instruments with advanced analytical capabilities detection became possible in low part per trillion (ppt).

As a result of ongoing health concerns, in 2009 the US Environmental Protection Agency (EPA) drew up a short-term health advisory, and published its first validated method for PFAS compounds in drinking water, with detection limits of less than 2 ppt.

References

1. For a recent overview covering the nineteenth and twentieth centuries, see E. Homburg and E. Vaupel, eds., *Hazardous Chemicals: Agents of Risk and Change, 1800-2000* (New York and Oxford: Berghahn, 2019; paperback edition 2024).
2. A.S. Travis, "The Discovery and Analysis of PFAS ('Forever Chemicals') in Human Blood and Biological Materials", *Substantia,* 2024, **8**(1), 7-24. doi: 10.36253/substantia-2377.
3. J. Lovelock, "Atmospheric Fluorine Compounds as Indicators of Air Movements", *Nature*, 1971, **230** (9 April), 379.

Anthony S. Travis

The Old Quantum Theory to Quantum Mechanics and Chemical Bonding in the First Half of the Twentieth Century (mainly in small molecules)

Chemists during the nineteenth century, above all after the International Chemical Congress in Karlsruhe of 1860, developed pictures of many molecules that are still regarded as correct today. They elucidated the topologies of molecules (which atoms were bonded to which), for instance August Kekulé's ring structure of benzene. Even geometries in three dimensions were elucidated, such as tetrahedral geometries surrounding carbon atoms in many molecules. Chemists' results and those of physicists using the kinetic theory of gases overlapped to a modest degree, for instance in relation to the atomicity of molecules in gases and vapours.

In the early twentieth century, significant advances in physics and chemistry became more closely related, as indicated by the foundation of the Faraday Society in the UK and of the *Journal of Chemical Physics* in the USA. Understanding of the (electronic) nature of the bonds that combined atoms into molecules was a common endeavour of the two sciences.

The Bohr "planetary" model of the hydrogen atom and his electronic structures for atoms formed a basis for investigating the nature of the bonding between atoms within molecules; these structures included structures for the inert gases helium to radon, which had been isolated and characterised from 1894 onwards. The fact that the majority of molecules had an even number of electrons stimulated the concept of the electron pair shared between atoms to form a bond between them. In many molecules the bonding achieved for the participating atoms mirrors the stability of electronic structures identical with those of the inert gases, with two electrons in the case of helium and otherwise an outer octet. Detailed electronic structures of molecules were devised for a wide range of molecules culminating in Nevil V. Sidgwick's *The electronic theory of valency* of 1927 ("valency" meaning the capacity of an atom to form bonds with other atoms), which has been described as "a masterpiece of the old quantum theory", and many of the ideas in which survive in 2025. A significant problem had arisen with molecules for which a special form of electron pair bond had to be devised if the outer octets were to be formed. To validate this special form, Sidgwick, following Samuel Sugden, made use of an unusually constructed and nowadays mostly forgotten molecular property, the "parachor". The expression for the parachor includes molecular weight,

liquid surface tension, and liquid and vapour phase densities, with the surface tension term raised to the power ¼.

Also in 1927, Walter Heitler and Fritz London presented a quantum-mechanical theory of the electron-pair bond. Linus Pauling and others in the 1930s reinforced many earlier concepts of chemical bonding by quantum-mechanical calculation, and furthermore explained away some of its anomalies. In 1939, Pauling presented quantum mechanical results without their proofs for the generality of chemists in his large and influential book *The Nature of the Chemical Bond*. Pauling in 1939 had available far more physical data to support his conclusions than was available to Sidgwick in 1927 – from spectroscopy, dipole moment measurements, electron diffraction, and X-ray diffraction; the parachor had outlived its usefulness.

Pauling primarily considered a molecule in terms of electron-pair bonds between pairs of atoms, subject as necessary to "quantum mechanical resonance" (so that, for instance, if there were two equivalent ways of arranging the bonds, the real molecule would be represented by a linear equal combination of two respective hypothetical wave functions). This became known as the "valence bond" (VB) approach. Contemporarily, others developed the molecular orbital (MO) approach. Orbitals for the entire molecule were generated by linear combination of atomic orbitals, and the available electrons were allocated to these; this built in the possibility of bonding being delocalised over more than two atoms. By mid-century, the value of the MO approach was recognised, especially in relation to the treatment of molecules such as benzene. An important experiment supporting the treatment was made in 1954 at the privately-funded, short-lived Hickrill Chemical Research Foundation in the USA.

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BOOK REVIEW

P.J.T. Morris, *The Polymer Revolution – A Journey Through Polymer Science* (London: Royal Society of Chemistry, 2025) Paperback, Pp. 240, ISBN: 978-1-78262-827-9, £27.99.

This book, by the former Chair of the RSC Historical Group, Peter Morris, is an account of the history of polymer science. It covers the years from 1830 to 1980, a period in which there were such major changes in understanding that they can rightly be considered a revolution.

The book contains twelve chapters following a roughly chronological order. After an introduction, there are three chapters taking the story to about 1920. In this period, the plastics industry was established, based primarily on rubber and cellulose. Scientific understanding of polymers was sketchy but nonetheless successful products emerged and found widespread use in everyday life.

Chapter two covers the prehistory of polymers. The earliest polymer-based material exploited was wood, whose use dates back thousands of years. By the nineteenth century, other natural polymer products had become commercially important, specifically shellac and rubber, and also natural fibres (cotton, linen and silk).

Chapter three describes the rise of the plastics industry, based on materials such as celluloid, a derivative of cellulose, phenol-formaldehyde (known commercially as Bakelite) and urea-formaldehyde. Bakelite was developed by Leo Baekeland, but had several disadvantages. It was opaque, could only take dull colours and had a noticeable smell. However, it was suitable for industrial uses, and Baekeland became very rich from it.

Chapter four concentrates on rubber and cellulose, and also the question of the size of polymer molecules. Rubber is a natural product but in the late nineteenth century several attempts were made to prepare a synthetic version. These were generally unsuccessful as the product was expensive and its properties were inferior. Synthesis was also difficult because chemists did not know what the target molecule was.

Chapter five describes the critical developments that led to our modern understanding of polymers. This has often been presented as a triumph of the solo genius, Hermann Staudinger, but the truth is more nuanced. Around 1920, the concept most favoured by chemists was that polymer molecules were of relatively modest size, and held together by secondary forces in aggregates called micelles. The term micelle had been proposed by the Swiss botanist Carl von Nageli in 1858, based on observations from microscopy. Nageli observed fibrils in plant tissue under the microscope and reasoned that there must be a state of assembly between them and the molecules of which they were made. He suggested the term micelle for these assemblies.

This was the state of understanding when Staudinger emerged to advance the macromolecular hypothesis. Staudinger was an organic chemist at the Swiss Federal Institute of Technology in Zurich, and he proposed not only that

polymers consisted of large molecules, but also that they were rigid rods with unreactive end-groups. Both of these latter ideas turned out to be wrong.

At least as significant in establishing the macromolecular concept as Staudinger's ideas was the work of Hermann Mark and Kurt Meyer, at the chemical company IG Farben. In 1928, they proposed that cellulose had long valence chains held together in bundles by secondary forces. This was a modified version of the micelle hypothesis, and was sneered at by Staudinger. Unfortunately for him, it turned out to be correct. As Morris shows, this debate was won as much by Mark and Meyer as by Staudinger, even though the latter was awarded the Nobel Prize for his contribution.

In September 1935, the Faraday Society held a meeting in Cambridge to consider the nature of polymers, and the meeting concluded that they were macromolecular. This was the end of the debate. From then on, nobody seriously opposed the concept of large molecules. This is clear from the remaining chapters of the book. They cover The New Polymers (chapter six), Polymers in the Second World War (chapter seven), Physical Chemistry of Polymers (chapter eight), Stereo-regular Polymers (chapter nine), High Performance Polymers (chapter ten), Different Ways of Studying Polymers (chapter eleven) and Polymers and the Future (chapter twelve). The latter raises a number of pressing questions, not least about the likely impact of Net Zero on the production of these materials.

The book is very well written and the story unfolds in a compelling way. Each chapter ends with sections on further reading and references, and includes pictures of the key scientists involved, together with their brief biographies. Overall, the book is both thorough and scholarly. It is a worthwhile addition to the literature, and members of the Historical Group will find it interesting. As such, I recommend it strongly.

John Nicholson

RSC HISTORICAL GROUP MEETING REPORT

History of Astrochemistry Meeting

Thursday 16 October 2025, Burlington House, Piccadilly, London

This meeting was organized as the online talk about the history of astrochemistry given by Catherine Walsh in February 2023 had been very popular, with over a thousand views on the group's YouTube channel. I am very grateful to Jeremy Shears, Mike Edmunds and Martin McCoustra of the

RSC Astrochemistry Group for their help in suggesting speakers and giving advice more generally. I am also indebted to the RSC Astrochemistry Group for publicising the meeting to its members and for agreeing to share half the cost of the meeting. I am also grateful to the Society of the History of Astronomy for its support and the Royal Astronomical Society for a grant to cover the travel costs of an overseas speaker. We are currently exploring ways of publishing the papers given at this meeting. The meeting was held, as usual, at RSC's premises at Burlington House. Seventy people registered for the meeting, mostly historians of chemistry and some astrochemists. The talks were divided into historical talks before lunch and more technical talks about the more recent history of astrochemistry by astrochemists. My thanks to all our speakers and to the many people who attended.

Speakers at the Astrochemistry Meeting: Jonathan Rawlings, John Black, Jon Hare, Ileana Chinnici, Mike Edmunds and Simon Mitton (left to right).

Peter Morris
Meeting Organiser

Summary of Talks

Early History of Astronomical Spectroscopy Ileana Chinnici

In the 1860s scientists discovered that, once dispersed through glass prisms or diffraction gratings, the light from stars and other astronomical objects such

as comets and planetary nebulae revealed their chemical composition. Actually, the existence of dark lines in the solar spectrum was known since the beginning of the nineteenth century, but their interpretation became clear when the radiation laws were formulated. Spectral analysis revealed that the celestial bodies are made of the same chemical elements detected on the earth. The progressive application of spectral analysis to the study of celestial bodies gave surprising results. In the years 1863-1869, the Jesuit priest Angelo Secchi, a pioneer in astronomical spectroscopy, found that stars can be classified on the base of their spectra. He initially proposed three types, then extended to four. Secchi's classification was the base of the modern spectral classification of stars, made at Harvard Observatory in the 1890s. The spectra of comets, nebulae and novae were first studied by William Huggins who can be considered the father of astrochemistry. Some new lines, not corresponding to those of terrestrial elements, were observed in some nebulae in 1864 and during total solar eclipses of 1868 and 1869, respectively in the prominences and in the corona. The existence of new elements, called nebulium, helium and coronium was hypothesized. Only helium, however, was confirmed, as it was later detected by William Ramsay in some radioactive minerals on the earth. The successful results obtained by astronomical spectroscopy disoriented the classical astronomers, who often adopted a defensive purist attitude, against the contamination of astronomy with other sciences. In the end, the "new astronomy" developed in separate establishments, the "astrophysical" observatories (the first being Potsdam in Germany, Meudon in France and South Kensington in UK), marking the rise of new scientific disciplines, namely astrophysics and astrochemistry.

Element Abundances in the Stars and Beyond, c. 1925-1940 Helge Kragh

As indicated by the spurious elements 'coronium' and 'nebulium', even in the early twentieth century it was possible to hypothesize elements in the heavens different from those found on Earth. The consensus view at around 1920 was that the chemical composition of the stars resembled the Earth, but it was questioned by C. Payne who in 1925 suggested an anomalous high percentage of hydrogen and helium. Due to further work by A. Eddington, W. McCrea, A. Unsöld and others, in the early 1930s the preponderance of hydrogen became broadly accepted. In 1938, B. Strömgren calculated 60% H and 36% He for the Sun, which inspired C.F. von Weizsäcker to his cosmogonic theory of the same year. A large amount of cosmochemical data were compiled, also in 1938, by the Norwegian mineralogist V. Goldschmidt whose graph of the relative element abundances in the universe was the first of its kind. After

World War II, his graph proved instrumental to the Big Bang cosmology developed by G. Gamow and his associates. As regards the term 'cosmochemistry', it was coined by R. Wildt in an article of 1940.

Seven Steps to Element Synthesis: B2FH Simon Mitton

Hydrogen and helium constitute ninety-eight per cent of the material universe, with the remaining ninety stable elements making up the balance of two per cent. This talk gave an account of attempts to understand the origin of the elements from ancient times until the 1950s. when a consistent picture emerged: hydrogen and helium are primordial from the big bang, and the remainder of the chemical elements were synthesised by nuclear reactions in massive stars. The ancients believed the primordial elements to be Earth, Fire, Air and Water. Robert Boyle defined an element as a primitive and simple body of which the mixed chemicals were composed. In the eighteenth century it dawned on geologists that the true nature of the physical world was at odds with the imaginary world of biblical accounts. In 1815 William Prout noted that the relative atomic mass was an exact multiple of the mass of the hydrogen atom. Work on salts of radium by the Curies established radiochemistry as a new field, underpinned by the discovery of radium and polonium and reinforced by Ernest Rutherford's discovery of the ultradense atomic nucleus. By the late 1930s nuclear astrophysicists suspected that nucleosynthesis took place in the cores of supermassive stars that exploded as supernovae.

Carbon Astrochemistry and the Discovery of Buckminsterfullerene
Jonathan Hare

C_{60}, Buckminsterfullerene and the family of cages (the Fullerenes) were discovered in 1985 during laboratory experiments aimed at probing the formation of long chain carbon molecules from carbon stars and other carbon rich objects in space and in the interstellar medium (ISM). In 1990 The Kraetschmer-Huffman carbon arc technique allowed the fullerenes to be made in bulk quantities and their properties investigated in detail both here on earth and in space. We now know that in addition to diamond and graphite, carbon can form chains, rings, cages as well as spherical particles and tubes (nanotubes). In addition, endohedral Fullerenes can form with atoms and small molecules within the cages. The result is a varied range of fairly complex self-assembling structures, that may play important roles throughout the universe and help solve problems in such diverse areas as the Diffuse

Interstellar Bands (DIB), the unidentified ultraviolet feature (ca, 217 nm), as well as particle and grain formation and the composition of molecular clouds.

H.W. Kroto, J.R. Heath, S. O'Brean, R.F. Curl, R.E. Smalley, "C_{60}: Buckminsterfullerene", *Nature,* 1985, 318, 162-163.

H.W. Kroto, "Space, Stars, C_{60} and Soot", *Science,* 25 November 1988, 1139-1145,

J.P. Hare and H.W. Kroto, "A Postbuckminsterfullerene View of Carbon in the Galaxy", *Accounts of Chemical Research* 1992, 25, 106-112.

W. Kraetschmer, W.L. Lamb, K. Fostiropolos, D.. Huffman, "Solid C_{60}: A New Form of Carbon", *Nature,* 1990, 347, 354-358.

J.P. Mair and E.K. Campbell, "Fullerenes in Space" *Angew. Chem. Int. Ed.,* 2017, 56, 4920-4929.

Alexander Dalgarno and the Development of Astrochemistry
John H. Black

The interdisciplinary field of astrochemistry arose during the 1970s as observations in previously unexplored parts of the electromagnetic spectrum began to reveal the extent of a molecular component of interstellar matter with a surprisingly rich chemistry. Astrochemistry expanded further in order to explain the role of atomic and molecular processes in a broad range of phenomena in the universe. It is instructive to describe the current scope of astrochemistry using the career and accomplishments of Alexander Dalgarno as an organizing principle. Dalgarno helped to establish a self-sustaining community of astrochemists around the world. His own research interests highlight the early development of astrochemistry and anticipate much of its later evolution. His theoretical investigations of fundamental atomic and molecular processes lie at the heart of the subject.

The First Detection of Molecules in Space Jonathan Rawlings

Molecular astrophysics is a relatively new discipline, with the great majority of the 240+ known interstellar molecular species being identified within the last forty years. However, the earliest detections were made in the 1930s, long before the advent of radio astronomy in the late 1950s, and most especially mm-wavelength telescopes in the late 1960s, which revolutionized the field. The early studies utilised visible spectra, obtained by a small band of observers at the Mount Wilson observatory in the period 1934-1937. This resulted in the detections of the radicals CH (1937), CN (1940) and CH^+ (1941). These species were identified in the spectra of starlight passing

through diffuse interstellar matter. There was then a gap of twenty-two years before the next detection (OH, in 1963) and the most abundant molecules in interstellar space, H_2 and CO, were not detected until 1970. The earliest detections were crucial pathfinders; they dispelled the prevailing scepticisms about the survivability and detectability of molecules in interstellar space, and yielded some fascinating results along the way. Perhaps the most significant of these was the use of the CN observations by McKellar (1940) to deduce that the temperature of interstellar space must be ~3K; pre-empting the more famous discovery of the Cosmic Microwave Background by a quarter of a century.

A History of the Chemical Analysis of Extragalactic Systems

Michael G. Edmunds

In 1864 William Huggins recorded looking at the spectra of the "nebulae" M31 and M32, but came to no strong conclusions. For many years thereafter, the faintness of extragalactic objects precluded measurement of their spectra until application of technological advances around 1965-1970 replaced the use of photographic plates. Although some perceptive conclusions had been drawn from the colours of galaxies and their star clusters, it was not until electronic detectors (and their associated computers) had been developed, and exploited during the period 1970-1990, that the foundations for chemical analysis of extragalactic systems could be laid. Analysis of HII regions in dwarf irregular galaxies from 1972 began to establish the true – and previously uncertain - primordial helium abundance. In the years 1974-1978 the abundances in HII regions in the Magellanic Clouds were measured. Then the development and calibration of empirical "strong-line" metallicity estimators established that nearby spirals (some thirty had been observed by 1990) showed spatial gradients in oxygen abundance of up to a factor of ten across their discs. The effect of increased metal abundance on populations of stars is to redden the observed colours. During the same period (1970-1990) spectrophotometric observation of both broad and selected narrow-bands in elliptical galaxies established the existence of both colour gradients within some systems (implying metallicity gradients) and a general colour versus absolute magnitude relation (implying a clear mass-metallicity relation). The first observation in 1977 of X-ray emission from highly ionised iron in the intergalactic gas in clusters of galaxies suggested a metal abundance not far from that expected in the cluster galaxies themselves, but detailed chemical analysis was only possible after 1990.

Laboratory Astrochemistry: Thirty Years of Gas-Phase Chemistry in the Extremes of Cold and Dark

David Carty

This talk traced the scientific and technical development of low-temperature reaction kinetics relevant to interstellar molecular clouds. These vast, frigid regions (10–50 K) host over 300 molecular species and are the birthplaces of stars. The talk used cyanopolyynes as an example—linear carbon-chain molecules whose observed interstellar abundances once defied theoretical prediction. Early astrochemical models, led by Eric Herbst in the 1980s, underestimated such abundances because they neglected fast neutral–neutral reactions. The breakthrough came from the Anglo-French CRESU technique (Cinétique de Réaction en Écoulement Supersonique Uniforme), which reproduced molecular-cloud temperatures in controlled supersonic gas flows. Developed through collaboration between Ian Smith and Bertrand Rowe, and later advanced at Birmingham and Rennes, CRESU enabled precise measurements of rate coefficients for key radical reactions such as $CN + C_2H_2$ and $C_2H + C_2H_2$. Over three decades, this collaborative programme established fundamental data for modelling cold interstellar chemistry and earned the 2000 EU Descartes Prize. Recent extensions—including product detection via chirped-pulse microwave spectroscopy—are now revealing reaction branching ratios, further refining our understanding of astrochemical synthesis pathways under extreme cosmic conditions.

RSC HISTORICAL GROUP WEBINAR REPORTS

Michael Combrune and the Chemistry of Brewing in the Eighteenth Century

John Powers (September 2025)

Who doesn't want a better beer? Certainly, the small, London brewer, Michael Combrune, did. He looked at the inconsistencies in the quality of English beer and decided that brewing had to be perfected by reshaping the brewer's practices with philosophical rigor and chemical knowledge. So, in the 1750s and 1760s, Combrune advocated for the establishment of "philosophical brewing", built upon the chemical theory of Herman Boerhaave and the use of instruments new to brewing, like thermometers, to control brewing processes. This talk showed that ultimately English brewers rejected most of Combrune's ideas as "too philosophical", yet his programme was not a complete failure. Some brewers adopted select parts of Combrune's programme, specifically in areas where his methods could be integrated into traditional practices to streamline the production of beer.

Colours from the Past, an Inspiration for Today

Dominique Cardon (October 2025)

Natural organic colourants were used worldwide by all civilisations since prehistoric periods, until their replacement by synthetic colourants for all industrial applications. With the emergence of a society more conscious of the environmental challenges faced by our globe, and the development of a new "green economy", they attract renewed interest. Ongoing advances in archaeological research and heritage sciences are revealing how early humankind endeavoured to master the art of dyeing. Recently published eighteenth-century dyers' recipe books illustrated with dyed textile samples offer a new contribution to the history of colours and colour nomenclature through the combined approach of colorimetry and experimental archaeology. The reproduction of historical dye processes is showing the beauty and fastness of those colours obtained from natural colourants, inspiring potential applications in various industrial branches. In her lecture, Dominique Cardon gave an overview of these developments, with examples from collaborative projects she is participating in, or being informed about, as the scientific director of several recent international symposia on natural dyes.

The Dawn Fisherman: Friedrich Miescher and the Discovery of DNA

Kersten Hall and Ralf Dahm (November 2025)

Thanks to cinema blockbusters such as the Jurassic Park/World series or any number of Marvel superhero offerings, DNA has become an icon in popular culture. In TV debates, electoral candidates talk about certain policies being "in their DNA"; sports coaches talk about styles of play being in the DNA of their team; and in 2022, the semi-final entry in the popular TV show, *The Great British Bake-Off* featured a DNA double-helix baked in Krokan pastry. Yet if asked who discovered DNA, most people (including most scientists) would struggle to give an answer. If pushed, they might offer the names of scientists James Watson and Francis Crick who are today commemorated with a plaque on the wall of The Eagle pub in Cambridge city centre for having first announced there in February 1953 that they had found "the secret of life". But DNA had been discovered long before Watson and Crick are supposed to have gone bursting into The Eagle. For almost a century earlier, working in a freezing cold former kitchen of a medieval castle, Swiss scientist Friedrich Miescher had first isolated a novel substance that he named "nuclein", and which today we know as DNA. Based on the forthcoming book *The Dawn Fisherman: Friedrich Miescher and the Discovery of DNA* by

Kersten Hall and Ralf Dahm, this talk explored the life and work of this rather tragic figure who died aged only fifty-one, burdened by a gnawing sense of things left undone and missed opportunities. Moreover, it shows why, perhaps today more than ever, Miescher's story still matters.

Recreational Chemistry: Three Centuries of Chemical Amusement

Colin Johnson (December 2025)

The approach of Christmas is a good time to reflect on chemistry as fun. This talk explored some historical examples of chemistry being practised as a hobby, or for the entertainment of others. It featured three fascinating individuals from the eighteenth, nineteenth and early twentieth centuries – just one of whom is well-known. The talk also explored the evolution of home chemistry books and the chemistry sets that followed and one or two twenty-first century examples of "chemistry for leisure". It concluded with a couple of chemistry items specially devised for the festive season.

RSC YouTube Channel

The recordings of a number of previous online lectures can be found at the Historical Group's playlist on the RSC YouTube Channel:

https://www.youtube.com/playlist?list=PLLnAFJxOjzZu7N0f5-nVtHcLNxU2tKmpC

MEMBERS' PUBLICATIONS

If you would like to contribute anything to this section, please send details of your historical publications to the editor. Anything from the title details to a fuller summary is most welcome.

Michael Freemantle, *Nature's Amazing Chemistry* (Cambridge: Royal Society of Chemistry, 2025).

Nature is the supreme chemist. It has created an abundance of chemical systems of bewildering complexity and diversity including the readers of this newsletter and the author of this book. We are all chemical products consisting of an ever-changing array of chemical components with chemical and physical properties that combine to make each one of us a unique individual. British chemist and Nobel laureate George Porter summed it up as follows: Every human is "a biochemical system living in a chemical world". And that also applies to every living organism that has ever existed on our planet.

The chapters in this book sketch examples of the author's fascination with nature's awesome chemistry. They cover an eclectic and fairly random choice of topics, often triggered by curiosity, for example, while out walking, watching TV documentaries, reading the scientific literature – or by just looking out of the author's study window at the world outside.

Chapter one is a wide-ranging chapter that introduces some of the main themes of the book: the complexity and diversity of nature's chemistry, the challenges the chemistry has posed to chemists, the huge numbers of chemicals that nature creates, and how humans have used and abused nature's chemistry. Chapters two to eleven explore specific aspects of the chemistry of animals: beavers, sheep, snakes, lobsters, birds, beetles, snails, tardigrades, humans, butterflies, horses and pigs. Chapters twelve to nineteen provide snapshots of some of the chemistry of plants such as snowdrops, lady's bedstraw, poppies, wild cabbage and trees. Chapters twenty to twenty-five focus on a few examples of nature's inorganic chemistry: atmospheric gases, metals and minerals. The final chapter on soil does not fit into any of these three categories - animal, vegetable and mineral – as soil comprises all three. The book is aimed at the general reader who, like its author, is intrigued by the chemistry of our existence and the planet we live on.

Vincent Daniels, "Alexander Scott and the Early Years of the British Museum's Research Laboratory (1920–1924)", *Studies in Conservation*, 2025, 1–12.

Scientists were occasionally consulted on the care of the British Museum's collection right from its creation in 1753. In 1920 a laboratory was created which would become a permanent fixture. It was headed by Alexander Scott (1853-1947), who was a very experienced chemist, having worked at the Davy Faraday Research Laboratory under James Dewar and alongside W.J. Russell, whose daughter he eventually married. Scott was also a past President of The Chemical Society. The formation of the Museum's Research Laboratory is described, with the move from a temporary laboratory into a more permanent building. The Laboratory was initially run by the Government's Department of Scientific and Industrial Research. The first five years of existence are covered, with the early areas of research described and the first staff appointed. It was soon realised that staff in curatorial departments needed to be trained in the newly developed methods and materials.

The article is available open access at:

https://www.tandfonline.com/doi/full/10.1080/00393630.2025.2472111

Peter J.T. Morris, *The Polymer Revolution – A Journey Through Polymer Science* (London: Royal Society of Chemistry, 2025).

A pdf of chapter one of Peter Morris's book is available at:

https://books.rsc.org/books/monograph/2378/chapter/8736652/An-Introduction-to-Polymers-and-Their-History?searchresult=1

Chapter one opens with a discussion about whether the development of polymer science between 1830 and 1980 can legitimately be called a revolution. The definitions of the terms *polymer* and *macromolecule* are explored, with surprising results in the case of *macromolecule*. This is followed by a short history of polymer science. A brief introduction to polymer chemistry and polymer technology is provided. Please also see the review of the book in this issue.

PUBLICATIONS OF INTEREST

The following journal issues have been published since the summer 2025 *Newsletter* was completed.

Ambix, The Journal of the Society for the History of Alchemy and Chemistry, vol. **72**, issue 3-4, August and November 2025

Fire Arts: Heat Technologies, Matter Theory, and Agency in the Premodern World

Hannah Elmer and Tillmann Taape, "Working Fire: Cosmologies, Agencies, and Methods".

Tillmann Taape, "Subtle Fire: Distillation as Low-Heat Technology and the Agency of Human Art".

Carmen Schmechel, "The Goldilocks Moment: Fire, Material Change, and Critical Time in Medieval Metallic Transmutation".

Tianna Helena Uchacz "Fire Technologies of the Low-Heat Artisan in Early Modern Europe".

Andrés Vélez-Posada, Blowing Fire: Exploring Ancient Amerindian Metallurgy Through a Furnace Model

Hannah Elmer and Thijs Hagendijk, "The Historical Furnace as Assemblage: Space, Circulation, and Early Modern Fire Management".

Peter Oakley, “Fire Management in Practice: Building and Managing Charcoal-Fired Assay Furnaces as Experimental Reconstructions”.

Katharina Vones and Peter Oakley, “Rounding Up: Undertaking Experiential Research on Granulation Techniques in a Charcoal-Fired Furnace”.

Márcia Vilarigues, Thijs Hagendijk, Andreia Ruivo, Alexandra Rodrigues and Carla Machado, “Powder, Fire, Glass: The Reproduction of Blue Enamels and the Role of Fire in Seventeenth- and Eighteenth-Century Instructions”.

Yijun Wang, “The Goddesses of Metal and Fire: Artisanal Knowledge, Embodied Experience, and the Reframing of Smelters’ Cult in China, Fourteenth to the Nineteenth Centuries”.

Further details on all the articles, many of which are available open access can be found at: https://www.tandfonline.com/toc/yamb20/72/3-4

Bulletin for the History of Chemistry, vol. 50, number 2, 2025

William B. Jensen, “Ask the Historian: Origin of Stereochemical Line and Wedge Symbolism”.

Robert B. Heimann, “The German Polymath Ehrenfried Walther von Tschirnhaus (1651-1708) and His Pursuit of the European Hard-Paste Porcelain Formula”.

Evan W. Culver and Seth C. Rasmussen, “From Regnault to Baumann: The Early History of Poly(Vinyl Chloride)”.

Ernesto Damiani, “Robert Bunsen’s Forgotten Wedding: Anecdote, Absent-Mindedness and the Origins of a Scientific Archetype”.

D.M. Behrman and E.J. Behrman, “Introduction to a Little-Known Memoir by Emil Fischer”.

Emil Fischer, “Primary Documents: Recollections from my Student Time in Strassburg, 1872-1875 (Translated by E. J. Behrman and D. M. Behrman)”.

William B. Jensen, Roger W. Kugel and Allan R. Pinhas, “Some Unusual Voltaic Cells”. Andrea Goldson-Barnaby, “Ackee and Jamaican Vomiting Sickness, A Historical Perspective”.

Peter J.T. Morris, “Letter to the Editor”.

Book Reviews

Dorothea Juliana Wallich, *Pathways to the Universal Tincture. Collected Alchemical Writings* (Alexander Kraft, ed.). Reviewed by Christoph Kießling.

Marco Beretta and Paolo Brenni, *The Arsenal of Eighteenth-Century Chemistry: The Laboratories of Antoine Laurent Lavoisier (1743-1794)*. Reviewed by Peter J.T. Morris.

Peter J.T. Morris and Peter Reed, *Henry Enfield Roscoe: The Campaigning Chemist*. Reviewed by Amy A. Fisher.

Dava Sobel, *The Elements of Marie Curie: How the Glow of Radium Lit a Path for Women in Science*. Reviewed by Annette Lykknes.

William Brock, *Fifth Business: A Life of the Chemist and Educationist* -54- *Henry Edward Armstrong*. Reviewed by Geoff Rayner-Canham and Marelene Rayner-Canham.

Anne Varichon, *Color Charts: A History* (Kate Deimling, transl.). Reviewed by Mary Virginia Orna.

Hubert Schmidbaur, *From Chemical Craftsmanship to the Art of Gilding Atoms*, Reviewed by Robert H. Crabtree.

Ryoji Noyori, *Research Should Be Fresh, Simple, and Clear*. Reviewed by Jeffrey I. Seeman.

Jeffrey I. Seeman, The Back Story: “Ryoji Noyori's Word of Honor”.

Back issues of the *Bulletin* from 1988 to 2022 are available open access on: http://acshist.scs.illinois.edu/bulletin_open_access/bull-index.php

SOCIETY NEWS

Society for the History of Alchemy and Chemistry

Brock Award for 2025

The Society for the History of Alchemy and Chemistry (SHAC) is pleased to announce the winner of the first Brock Award. The Brock Award honours Professor William ‘Bill’ Hodson Brock (1936-2025), one of the leading historians of chemistry of the last fifty years, and for outstanding contributions in the fields of the history of alchemy and chemistry.

The Brock Award for 2025 is given to Bernadette Bensaude-Vincent for her lifetime of outstanding work in the history of chemistry. For about four decades she has produced original and thought-provoking research in the history and philosophy of chemical and materials science, significantly shaping the historiography of chemistry. Her work stands as an inspiring

example of how innovative approaches in these fields can not only illuminate significant historical and philosophical ideas in the chemical sciences, they can also meaningfully contribute to addressing contemporary societal challenges. Bensaude-Vincent has played a key role in establishing collaboration and building scholarly communities across Europe, and in nurturing new generations of scholars in history of chemistry, both formally and informally.

Bernadette Bensaude-Vincent, a philosopher by training holds a doctorate from the University of Paris 1 Panthéon-Sorbonne. A professor at University of Paris Nanterre from 1989 to 2010, she moved to the University of Paris 1 Panthéon-Sorbonne. She is now professor emerita and a member of the French Academy of Technologies. She continues to publish innovative work and engage with both the scholarly community and public audiences.

The Brock Award will be presented to Bernadette Bensaude-Vincent at a special meeting in Oxford to honour Bill Brock's memory on 10 April 2026.

International Society for the Philosophy of Chemistry

The International Society for the Philosophy of Chemistry (ISPC) is devoted to the international exchange of ideas concerning the philosophical foundations of the chemical sciences and related areas. This exchange fosters discourse between chemists, biochemists, philosophers, historians, sociologists and educators.

Philosophy of chemistry concerns both internal questions arising from the methods, concepts and ontology unique to chemistry and chemical research as well as traditional questions in the philosophy of science, addressed from a chemical perspective.

The International Society for the Philosophy of Chemistry (ISPC) was officially formed in 1997. It organises an annual symposium, which in 2025 took place in Belgium and in 2026 will be hosted by the University of California Los Angeles. Members of the Historical Group with philosophical interests who would like to find out more about the ISPC and its activities should visit.

https://philosophyofchemistry.com/

FUTURE MEETINGS AND CONFERENCES

Remembering Bill Brock: Chemistry and Culture

Friday 10 April 2026

William 'Bill' Hodson Brock (1936-2025) was one of the leading historians of chemistry of the last fifty years. As Chair of the Society for the History of Alchemy and Chemistry (SHAC) and editor of its journal *Ambix*, he played a major role in the Society from the 1960s to the 2000s. He also wrote on the history of publishing, education and many other aspects of nineteenth-century science and culture, publishing in 1992 *The Fontana/Norton History of Chemistry,* a general history of chemistry from antiquity to the present. To commemorate his life, work and legacy, SHAC is organising a one-day meeting to be held on Friday 10 April 2026 at the Maison Française d'Oxford. Confirmed speakers include Alan Rocke and Bernadette Bensaude-Vincent, who is the first recipient of SHAC's newly established Brock Award. A full programme and registration details will be available at www.ambix.org in due course and also circulated on Mersenne and Chem-Hist.

Call for Abstracts – 29th Conference of the International Society for the Philosophy of Chemistry, 29-31 July 2026

The twenty-ninth annual conference of the International Society for the Philosophy of Chemistry (ISPC 2026) will be held from 29 to 31 July 2026, at the University of California Los Angeles (UCLA) under the auspices of the UCLA Department of Chemistry and Biochemistry and the International Society for the Philosophy of Chemistry (ISPC). https://philosophyofchemistry.com/

Proposals are invited which address a diverse range of contemporary questions in the epistemology and metaphysics of chemistry, in addition to historical and educational aspects of chemistry.

Confirmed Keynote Speakers:

Prof. Pieter Thyssen, Liège University, Belgium.

Prof. Guillermo Restrepo, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany.

Call for Abstracts

The organizing committee welcomes submissions on any topic in the philosophy of chemistry, including historical and educational presentations of

fundamental aspects of chemistry. Presentations will be thirty minutes, followed by ten minutes for Q&A. Plenary speakers will deliver longer talks. Zoom presentations will be allowed 20 minutes plus 5 for questions.

Candidate speakers should submit a one-page abstract (in Word format) of no more than 400 words (excluding references) by 31 March 2026 to scerri@g.ucla.edu

All abstracts must contain a title and be prepared for anonymous review. Please include your affiliations in the body of your email, and specify whether your paper will be presented in person or online. Submitted abstracts will be blind-reviewed by the scientific committee. Notifications of acceptance will be delivered by 20 April 2026.

Further details regarding the venue, program, and registration process will be provided in due course at the website for the International Society for the Philosophy of Chemistry. https://philosophyofchemistry.com/symposia-2/

Please direct any inquiries to Dr Eric Scerri, UCLA, scerri@g.ucla.edu