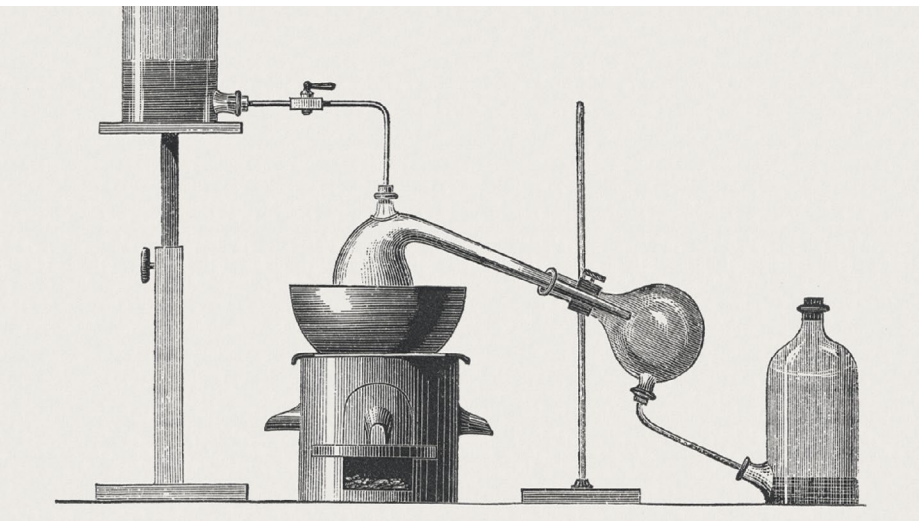
https://doi.org/10.1038/s41929-022-00868-2

Tools to understand catalysis

This issue presents a selection of retro News & Views articles that highlight the historical development of some spectroscopic and analytical techniques that might not be the most popular, but have nonetheless provided an important contribution to the elucidation of catalytic reactions.



The repertoire of techniques that a chemist at the beginning of the 20th century could use to interrogate a reaction was certainly less sophisticated than today. A quick look at Sabatier and Senderens' seminal report on CO_2 hydrogenation over a nickel catalyst[1] from 1902 reveals — and perhaps not surprisingly — no trace of advanced spectroscopies or chromatographic techniques. In fact, the French team could only rely on a rigorous eudiometric analysis and a good deal of chemical intuition.

Analytical science, and in particular spectroscopy, has flourished in the second half of the past century, advancing our ability to understand chemical systems to levels hardly imaginable before. The impact on catalysis has been enormous, and has allowed major discoveries on the structure–activity relationship of several homogenous, heterogeneous and biocatalytic processes of academic and industrial importance.

Certainly, some techniques are more popular than others, and this may reflect the cost of the instrumentation or their user friendliness, but eventually the popularity of a method depends on the history of its development.

"We hope that these short articles will serve as primers to embolden the next generation of catalysis scientists to learn about and experiment with different techniques, while providing an understanding of the context in which they have been developed."

In continuation of our effort to frame contemporary catalysis research in a historical perspective, this issue of *Nature Catalysis* features a fresh selection of retro News & Views articles that discuss interesting techniques that have found application in the study of catalytic mechanisms. However, rather than focusing on prevailing spectroscopic or chromatographic tools, the articles highlight methodologies that perhaps remain underutilized across the field, despite their unique potential.

Nuclear magnetic resonance (NMR) spectroscopy is one the methods of choice for the study of chemical reactions. Besides providing the most common set of experiments employed to elucidate the connectivity of molecules — proton, carbon and other two-dimensional spectra for example — NMR offers a range of techniques that come in handy to study the mechanism of a catalytic reaction. Parahydrogen-induced polarization (PHIP), for instance, allows the investigation of reactions that involve the formation of C–H bonds through hydrogenation of unsaturated compounds, and takes advantage of the spin properties of parahydrogen. In a News & Views, Gerd Buntkowsky and Torsten Gutmann recall the history of this technique and describe its physical principles, guiding the reader towards application of the method in catalysis and beyond.

In another article, Andras Bodi, Patrick Hemberger and Javier Pérez-Ramírez discuss photoelectron photoion coincidence (PEPICO) spectroscopy. This technique allows the capture of short-lived transient gaseous intermediates under operando conditions, and has recently been employed to shed light on numerous reaction mechanisms, including Fischer–Tropsch synthesis or methane oxybromination[2].

Finally, in his article, Nikolay Kornienko discusses the electrochemical quartz crystal microbalance technique. This was first developed in 1959 when Günter Sauerbrey discovered the quantitative relationship between the oscillating frequency of a piezoelectric quartz chip and its mass (described by the Sauerbrey equation). This technique can be used to measure miniscule changes in the mass of electrodes, and hence to monitor electrocatalytic processes that involve changes in mass[3].

Together with the related pieces published in our fourth volume, the articles from the current issue are becoming the foundation of our retro News & Views series. This collection will be regularly updated in the future with further contributions that highlight historical milestones in the field of catalysis at large. We hope that these short articles will serve as primers to embolden the next generation of catalysis scientists to learn about and experiment with different techniques, while providing an understanding of the context in which they have been developed. Hopefully, the retro News & Views series will also become a source of inspiration for more established researchers to widen their repertoire of methods for

Editorial

the study of catalytic reactions. We wish you pleasant reading.

Published online: 19 October 2022

References

1. Sabatier, P. & Sendersens, J. B. *Compt. Rend.* **134**, 514–516 (1902).
2. Hemberger, P., van Bokhoven, J. A., Pérez-Ramírez, J. & Bodi, A. *Catal. Sci. Technol.* **10**, 1975–1990 (2020).
3. Buttry, D. A. & Ward, M. D. *Chem. Rev.* **92**, 1355–1379 (1992).