Towards High Sensitivity Process NMR: Combining Hyperpolarisation and Benchtop NMR

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Nuclear magnetic resonance (NMR) spectroscopy is an extremely powerful analytical technique, which is widely used in research for a vast number of applications. However, typical high-field research instruments are expensive, large, and non-portable. Consequently, compared with other spectroscopic techniques, NMR is rarely used for reaction monitoring or industrial process analysis. Benchtop NMR instruments are much smaller, cheaper, and more portable, and so are more suited for process analysis.[1] However, the Achilles heel of NMR is its low sensitivity, which is especially true at the lower field strengths of benchtop NMR.

This presentation will highlight recent work using the Signal Amplification By Reversible Exchange (SABRE) hyperpolarisation technique to boost the signal intensity of benchtop NMR.[2–4] It will demonstrate that the technique can be highly efficient for both ^{1}H and ^{13}C experiments, and for a range of molecules. Typically, enhancement factors have been found to range from 100 to over 45,500 depending on the analyte of interest. This high level of signal enhancement makes it possible to analyse trace components, which is not usually possible with benchtop NMR. It also makes it possible to conduct natural abundance ^{13}C NMR experiments in a matter of seconds instead of several hours. This potentially allows ^{13}C NMR experiments to be used for reaction monitoring or industrial process control, where frequent results are essential.

Critically the SABRE technique is low-cost, fast, and easy to apply, so the overall cost and portability advantages of compact NMR are not compromised.[4] The large signal enhancement reported in this work paves the way for the development of highly sensitive and highly specific analysis methods for process analysis. The advantages and disadvantages of the technique will be highlighted, and discussed in terms of the implications for reaction and process monitoring, as well as for quantitative analysis.

References:
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