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Enhancing NMR of Slowly Relaxing Species Using a Controlled Flow Motion and a Miniaturized Circuit

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We have recently presented a 3D-printed NMR device based on a mini bubble-pump associated to fluidics and microdetection which can be installed on a commercial microimaging NMR probe head.[1] In addition to properties such as enabling efficient enrichment of the solution in gaseous and liquid hyperpolarized species, reactive species, or nutrients for cells, it can lead to a significant signal enhancement for slowly relaxing nuclei.[2] As between two scans fresh spins replace previously excited ones in the detection region, there is no need to wait for several relaxation times. Our approach based on the use of a closed-loop circuit at the NMR magnetic center for the solution presents two main advantages in addition to its low cost: i) pre-polarization is achieved for the whole solution volume, ii) this volume can be reduced to some tens of microliters.

We show that it enables more precise and frequent monitoring of chemical reactions. An additional modification leads to a stopped-flow system very efficient for instance for 2D NMR experiments with long mixing times.

Recent improvements, including in particular versions using inductive rf coupling, will be presented.

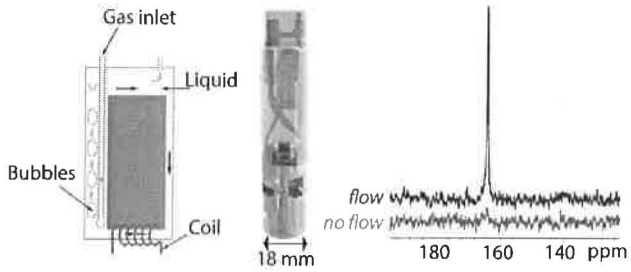


Figure 1. Principle of our mini airlift-pump and ^{13}C NMR spectra of urea recorded in static and flow modes.

(1) Causier, A.; Carret, G.; Boutin, C.; Berthelot, T.; Berthault, P. *Lab. Chip* **2015**, *15* (9), 2049.
(2) Carret, G.; Berthelot, T.; Berthault, P. *Anal. Chem.* **2017**, *89* (5), 2995.