

# Development of a versatile fluidic 3D printed device for NMR and MRI studies: application on hyperpolarized xenon studies

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**Introduction:** NMR suffers from weak sensitivity and as hyperpolarization is a non-equilibrium state, the effective dissolution and/or fast delivery of hyperpolarized species in the NMR detection area is a key step. We have developed a series of devices combining fluidics and micro-detection in this purpose. We present here three different applications of it and the corresponding methods to laser-polarized xenon.

**Methods:** Two families of fluidic devices have been built using a 3D printer. They are both based on a microsized NMR detection associated with a bubble pump which allows a circulation of the sample. The first version is installed on a commercial microimaging NMR product [1], the second one is more versatile and is inductively coupled with the NMR probe. [2]

**Result and discussion:** First, the devices have been characterized: <sup>1</sup>H velocimetry experiments have given information on the speed of the liquid in the detection region and the dissolution efficiency of hyperpolarized xenon has been estimated. Then the interaction between hyperpolarized xenon and a cage-molecule has been studied.

Biocompatibility of the devices for cell culture is obtained thanks to parylene coating. The effect of this coating has been assessed by cell culture assays of mammalian cells and the ability to make dynamic studies using hyperpolarized xenon has been validated by the addition of toxic on yeasts. Finally, the device has been modified in order to study of the interaction between gases and powders. The dynamic of the interaction between hyperpolarized xenon and some porous materials has been investigated.

**Conclusion:** This work demonstrates the possibility to use these versatile devices based on a bubble pump, fluidic channels and micro detection with hyperpolarized species and open a wide range of applications.

**References:** [1] Causier *et al.*, 3D-printed system optimizing dissolution of hyperpolarized gaseous species for micro-sized NMR, Lab on a chip. (2015) 15 (9), 2049-2054. [2] Carret *et al.*, Inductive Coupling and Flow for Increased NMR Sensitivity, Anal. Chem. (2018) 90 (19), 11169–11173.

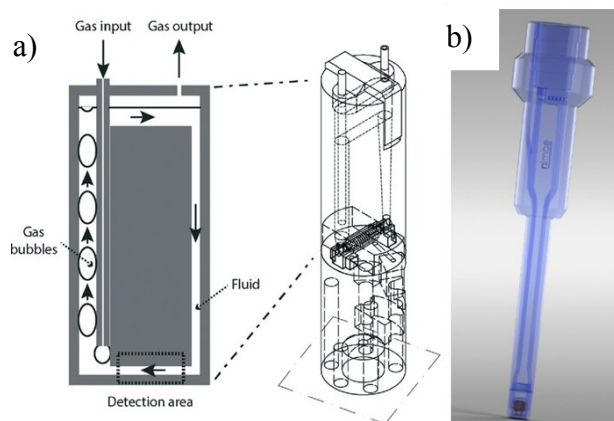


Fig. 1: 3D printed devices based on a bubble pump. a) plugged on a commercial microimaging NMR probehead, b) inductively coupled to the NMR probehead.