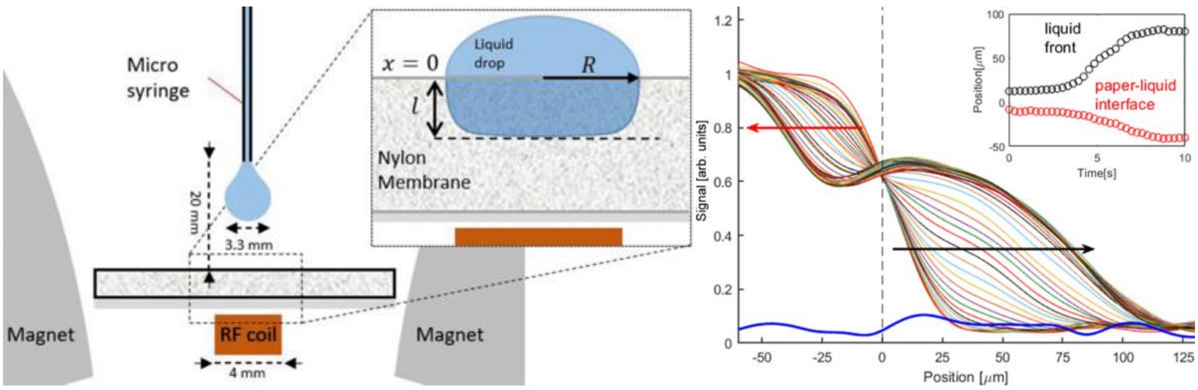
Capillary imbibition and swelling of thin paper sheets

The imbibition process inside paper sheets is a complex process [1], where effects such as swelling, penetration and wetting determine the capillary uptake behavior. Understanding all these processes can give crucial information for optimizing printing inks and media. Measuring liquid penetration is still a challenging task. Most experimental techniques can measure either swelling or liquid uptake in 'global' manner without spatial information. Here we demonstrate that our previously introduced high-speed NMR imaging technique [2] can visualize coherently swelling and uptake inside printing paper with spatial resolution. A schematic representation of the set-up is shown in the figure (left). Liquid distributions during penetration of a microliter droplet are shown in the same figure (right). The technique was able to observe both swelling and penetration. At the beginning (t = 0), the paper sample lies between 0 and 90 µm. As time progresses, the fluid front can be observed to move inside the printing paper (black arrow), while the paper swells (red arrow). The corresponding swelling front (red) and penetration front (black) are depicted in the upper right figure. In this presentation we will discuss the capillary uptake as a function of systematic variations in the paper sheet properties: sizing [3] (degree of hydrophobicity) and calendaring [4] (compression of the fibers). It will be shown that the penetration rate will be largely influenced by the amount of sizing as also a retardation in the uptake behavior that was firstly observed in paper samples. On the other hand, calendaring influences the pore structure and swelling behavior during liquid uptake. Measuring the liquid profiles at this time and length scales can provide crucial information in understanding the uptake behavior inside complex swellable media by providing information of both swelling and penetration coherently.



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