

μ -MRI on ion exchange resin interaction with nanoscale substances

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Introduction: Ion exchange resins are often used to remove nanoscale impurities from water. The interactions between resins and nanoparticles/molecular clusters determine the purification efficiency. Time resolved μ -MRI gives in depth insight into interactions and their kinetics.

Materials and methods: The interactions of nanoscale moieties ($\sim 2 - 80$ nm) with anionic and cationic polymeric ion exchange resin beads (~ 600 μ m) were studied by MRI at 400 MHz ^1H -Larmor frequency. RARE and FLASH pulse sequences were applied, using different rf coils depending on the length scale of the samples. Images with in-plane resolution down to 15 μ m x 15 μ m were measured with a μ -coil [1].

Results and discussion: Size and surface chemistry determine interactions between resins and nanoparticulate moieties. First, resin beds allowed the observation of interaction on the scale of ≈ 20 mm. Penetration kinetics were quantified at the next smaller length scale of resin stacks (Fig. 1) with a time resolution in the order of 4 min. The MR-images show a reduced signal intensity of the beads when a molecular contrast agent was absorbed (Fig. 1). Images were processed exploiting the circular geometry [2] to obtain the mean signal intensity averaged over the angle as a function of the radial coordinate of a single bead. The intensity profiles within a bead (Fig. 2) were modelled by a sigmoidal function to quantify kinetics. On the length scale of single beads, the localization of superparamagnetic nanoparticles on and in the beads was measured, exploiting the impact of the superparamagnetism of the nanoparticles on the static magnetic field. [3]

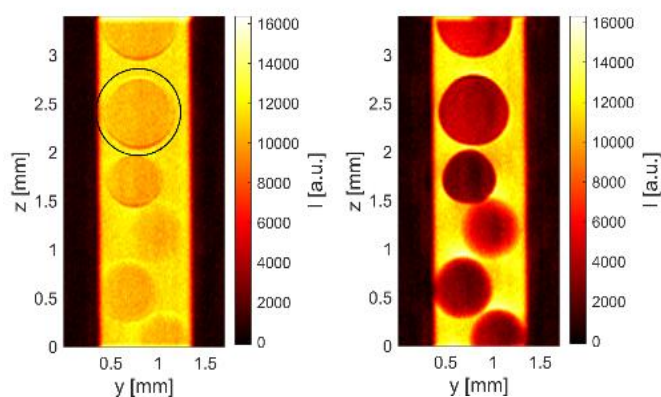


Fig. 1: Anionic resins beads in water (left) and in Magnevist solution after an exposure time of 1.5 h (right). The circled resin bead was analyzed for Fig. 2.

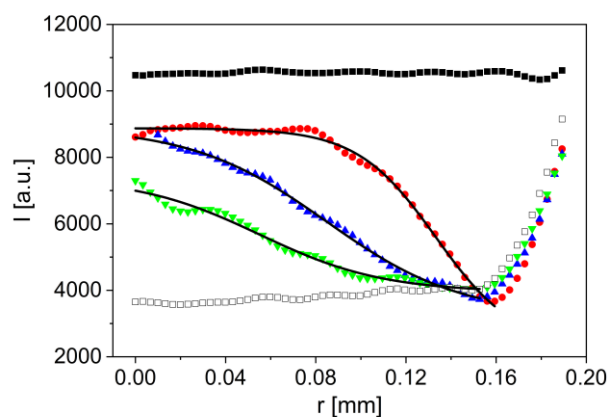


Fig. 2: Radial intensity profiles implicitly as function of the penetration time. The minimum indicates the transition between resin bead and surrounding solution.

References: [1] Bruker. Fruit fly meets microcoils – a magnetic resonance microscopy investigation of *Drosophila*. Accessed May 07, 2025. <https://www.bruker.com>.
[2] N. Schork et al., Magn Reson Chem., 2019, 4-5.
[3] L. Kontschak et al., AIChE Journal, 2024.