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Mobile NMR: Measuring Pixels, Images, and Spectra[1]

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The vision of bringing nuclear magnetic resonance out of the lab to the doctor's office, the chemical reactor, or the manufacturing site is becoming reality with the development of mobile NMR. Pioneered for well logging in the oil industry, the concept has been explored for materials testing in a more systematic way since the introduction of the NMR-MOUSE. This is a small, one-sided access NMR sensor which acquires the information of one pixel from a particular spot of a large object. As the sensor explores the stray-fields of a permanent magnet and an rf coil, the magnetic fields are inhomogeneous and the sensitive volume is limited to the region, where both fields are orthogonal and the Larmor frequency lies within the excitation bandwidth. By shaping the magnet and the coil geometries, the shape of the sensitive volume can be tailored to a thin slice or a larger volume a certain distance away from the sensor surface. In the first case, there is a strong field gradient in the depth direction, and in the second case, a homogeneous sweet spot of the field profile is desired. The first case is suitable for measuring high-resolution depth profiles, while the second case is suitable for chemical shift resolved spectroscopy and volume imaging. The basic concepts of open and closed mobile NMR sensors will be discussed along with applications from testing polymer products, cultural heritage, medical tissue, and rock cores.

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