

TABLE TOP MICRO FLUIDIC NUCLEAR MAGNETIC RESONANCE SPECTROMETER

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Nuclear Magnetic Resonance (NMR) spectroscopy is a powerful method for determining chemical composition, biological properties, and other interesting properties of fluids. NMR systems are typically very large and expensive due to the superconducting magnets that must be used and the liquid helium and nitrogen used to cool them. This paper describes the development of a portable NMR spectrometer utilizing small permanent magnets, microscale probes and sample capillaries for microfluidic analysis of biological fluids (blood, urine, tears, amniotic fluid, saliva, etc.) and chemical agent sensing (homeland security). The underlying design and fabrication principles in downscaling the technique will be described. The motivating factors for downscaling NMR include improvements in the signal to noise ratio, vastly smaller sample volume requirements, and reduced dependence on high performance magnets. This leads to increased sensitivity and field portability, at substantially lower cost.

The key to miniaturization is in the use of a permanent magnet assembly built from high permeability Vanadium Permendur. This permanent magnet assembly has been shown to generate a variable field through a creative implementation of ferromagnetic flux switches (3,000 - 23,000 Gauss). The development of a manufacturable process for the micro coil and capillary system is described. This process provides an effective capillary wall thickness of zero (100 percent fill-factor), which is key to maximizing the signal to noise ratio. Measurements from a prototype device show approximately 17 MHz shift in the resonant frequency of sample-filled coil for a 20 percent change in static field strength. The variation in static field strength is produced by changing the arrangement of the flux switches.

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