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First NMR Relaxometry using Outer Field of Single-sided HTS Bulk Magnet activated by Pulsed Field

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One of important application for HTS bulk magnets is compact NMR/MRI. We have developed a single-sided (unilateral) HTS bulk magnet and a home-built NMR spectrometer to get NMR relaxometry signals from the sample on the outside of the magnet. The NMR signal relaxation rate, the only parameter that is observed in NMR relaxometry, still gives us the information about the mobility of molecules, including fluctuations and diffusion, in the microscopic environment. This measurement method needs less magnetic field homogeneity compared to ordinary NMR spectroscopy. NMR relaxometers using permanent magnets are applied for food science to determine moisture content, solid fat content (SFC). HTS bulk magnets can supply higher magnetic field, which means higher sensitivity for shorter measurement time and stronger magnetic field gradient for higher spatial resolution. The bulk magnet was activated by pulsed field magnetizing method. Trapped magnetic field strength at the center surface of the cryostat was 1.32 T.
Our home-built NMR spectrometer is a key part of our achievement. A modified USRP-2920 (National Instruments) is applied as an NMR spectrometer. This device is called software-defined radio (SDR) and functions traditionally implemented in hardware are implemented by software. We have developed an NMR spectrometer software using LabVIEW and NI-USRP (National Instruments). Our spectrometer suits for compact HTS NMR/MRI magnets, because it is not only very compact and cheap, but also very flexible with higher sensitivity. The ¹H NMR signals at 47.8 MHz were observed using spin-echo excitation pulse, even the silicone rubber sample with 4 mm in diameter and 9.5 mm in length was settled in inhomogeneous magnetic field at 3.7 mm away from the center surface of the cryostat. We have succeeded to get ¹H NMR signals from a single-sided HTS bulk magnet by pulse field magnetization for the first time in the world.

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