Achievement of 1020 MHz NMR

T. Shimizu[1], K. Hashi[1], S. Ohki[1], S. Matsumoto[1], G. Nishijima[1], A. Goto[1], K. Deguchi[1], K. Yamada[1], T. Noguchi[1], S. Sakai[1], M. Takahashi[2], Y. Yanagisawa[2], S. Iguchi[2], T. Yamazaki[2], H. Maeda[2], R. Tanaka[3], Y. Nishiyama[3], T. Nemoto[3], H. Suematsu[3], T. Miki[4] and K. Saito[4]

[1]National Institute for Materials Science, 3-13 Sakura, Tsukuba, 305-0003 Japan

[2]Center for Life Science Technologies, RIKEN, 1-7-29 Suehiro, Tsurumi, Yokohama, 230-0045 Japan

[3]JEOL RESONANCE Inc. 3-1-2 Musashino, Akishima, Tokyo, 196-8558, Japan

[4]Kobe Steel Ltd. 1-5-5 Takatsukadai, Nishiku, Kobe, 651-2271, Japan

We have successfully developed a 1020 MHz (24.0 T) NMR magnet shown in Figure 1, establishing the world's highest magnetic field in high resolution NMR superconducting magnets.[1)] The magnet is a series connection of LTS (low-Tc superconductors NbTi and Nb_3Sn) outer coils and an HTS (high-Tc superconductor, Bi-2223) innermost coil, being operated at superfluid liquid helium temperature such as around 1.8 K and in a driven-mode by an external DC power supply. The drift of the magnetic field was initially ±0.8 ppm/10 h without the ^{2}H lock operation; it was then stabilized to be less than 1 ppb/10 hr by using an NMR internal lock operation. The full-width at half maximum of a ^{1}H spectrum taken for 1 % $CHCl_3$ in acetone-d_6 was as low as 0.7 Hz (0.7 ppb), which was sufficient for solution NMR. On the contrary, the temporal field stability under the external lock operation for solid-state NMR was 170 ppb/10 hr, sufficient for NMR measurements for quadrupolar nuclei such as ^{17}O; a ^{17}O NMR measurement for labeled tri-peptide clearly demonstrated the effect of high magnetic field on solid-state NMR spectra, as can be seen in Figure 2.

Fig.1 1020 MHz-NMR magnet. It weighs 15 tons, 5 meters in hights and high temerature superconducting coil inside.

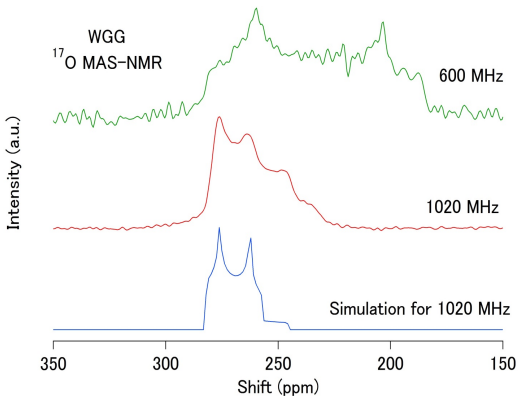

Fig.2 ^{17}O MAS NMR spectra of a labeled peptide L-tryptophanyl-glycyl-glycine dihydrate (WGG) taken at 600 MHz(14.1 T)NMR and 1020 MHz (24.0 T)NMR. Both resolution and sensitivity can be seen much improved in 1020 MHz compared with 600 MHz. Simulation for 1020 MHz is also plotted.

Reference

1) K. Hashi, et.al., Journal of Magnetic Resonance, 256(2015)30-33.