Developments of Extreme μSR Conditions at the RIKEN-RAL Muon Facility

Advanced Meson Science Laboratory, RIKEN Nishina Center,
2-1 Hirosawa, Wako, Saitama, 351-0198, Japan.
Isao Watanabe

RIKEN has constructed the RIKEN-RAL Muon Facility (RIKEN-RAL) at the Rutherford-Appleton Laboratory (RAL) [1]. Since the muon has a self-polarized spin with S=1/2, the muon can be used for material sciences to sense electronic states of materials. The worldwide strongest double-pulsed muon beams with the wide rage of the momentum from 25 to 120 MeV/c are available for material sciences at the RIKEN-RAL. Muon-spin relaxation measurements (μSR) using the spin-polarized muon beam have been carried out at the RIKEN-RAL from 1994 in collaboration with more than 50 groups in the world. Recently, requirements to use extreme sample conditions which are the high pressure and the low temperature with the tiny size of sample are growing up in order to progress advanced μSR studies of molecular materials. In our presentation, we will report developments of these extreme sample conditions especially for the double pulsed muon-beam available at the RIKEN-RAL Muon Facility.

Figure 1 shows the newly developed high-pressure cell for the RIKEN-RAL Muon Facility [2]. The high-pressure μSR setup for the pulsed muon beam has never been developed in the past in any muon facilities. Thus, the developed system for the RIKEN-RAL is the “only-one” in the world. We have collaborated with the high-pressure group of RAL and carefully designed keeping safety conditions of the use of the high pressure system at RAL. The big advantage of the gas-pressurized system is to change the gas pressure continuously and keep the desired pressure from the base temperature up to the room temperature. The high-pressure cell is pressurized by gas helium up to about 3 kbar using a high-pressure pump in the first stage and is finally pumped up to about 7 kbar using a gas intensifier. The pressure in the cell is held by a normal Bridgman clamp and piston, which are located at the rear of the cell. The material of the cell is CuBe. The diameter of the sample space is 18 mm and the depth is about 8 mm. The sample volume is about 2 cc. The is colled from the room temperaure down to 1.5 K. Tyhis high-pressure system has been started to be in use from this year and some high-pressure experiments on molecular materilas are now in progress [3].

Figure 2 show the existing fy-path setup for tiny sample. In usual cases, more than

200 mg of sample is needed to achieve the measureable singnal from a sample [4]. This is a strong restriction in the case of use of the pulsed muon beam at the RIKEN-RAL. The existing fly-path set up make measurements using tiny samples less than 200 mg possible down to 5 K in conjunction with a small gas-flow cryostat. In some cases, we coud try to use a tiny sample with aroung 50 mg in weight using this existing setup. However, recent requirements from the study of advanced molecular is to use tiny samples at low temperatures below 5 K. Thus, we are now preparing the similar fly-path setup for a ^{3}He cryostat which can be cool a sample down to 0.28 K. The design of the flt-path setup for the the ^{3}He cryostat has been completed and the machining is now going on. We expect to test this new setup before the spring time in 2009 and to use with real molecular samples from the summer time in 2009.

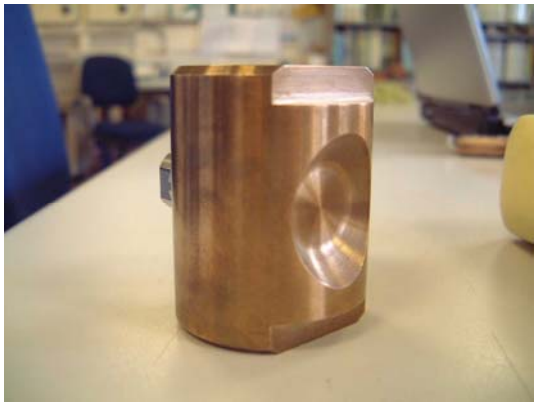

Fig.1: High-pressure cell developed for the RIKEN-RAL Muon Facility.

Fig.2: Fly-path setup for tiny size samples.

REFERENCES

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