PIEZOELECTRIC ACTUATOR DRIVEN VSM – FEASIBILITY TEST WITH THE 45T HYBRID MAGNET

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Introduction

The vibrating sample magnetometer (VSM) has been a powerful tool to measure absolute magnetic moment. The VSM is classified as a flux magnetometer, where a magnetic flux change induced by a vibrating sample is measured by a pair of pick-up coils. Usually, the vibration motion of the sample is generated by a driver head, where a set of permanent magnet and coils (like a loud speaker) located on top of the magnet delivers the vibration via a long sample rod. This conventional design has been successfully used with the NHMFL resistive magnets, but had some problems with the 45T hybrid magnet due to the large fringe field. We developed a piezoelectric actuator driven VSM to overcome the problem and demonstrated the feasibility of this technique.

Experimental

We built a VSM probe with a commercial piezoelectric actuator stack, whose maximum stroke is about 120 μm at room temperature at 150V bias. The piezoelectric actuator and a sample rod (total length ~ 30 cm) unit and the pick-up coils are shown in Fig. 1. Driving voltage and frequency can be tuned by a programmable function generator and pulse amplifier, which were chosen to be away from the normal modes of vibration. A lock-in amplifier is used to detect the phase sensitive signal from the pick-up coils using the driving signal as a reference.

Results and Discussion

Fig. 2 shows the signal from a vibrating 0.09 g Ni cylinder at the Hybrid magnet. The characteristic behavior of ferromagnetic Ni is clearly observed as sharp increase and saturation of magnetic moment. The resolution of the current setup (10^{-2} emu with the hybrid magnet, 10^{-4} emu with the superconducting magnet) can be improved by introducing a vibrating capacitor reference and the closed-loop control and detection. Another advantage of employing the short vibrating unit is to avoid the rubbing issue of the long sample rod, which was proven as increased base temperature holding time (> 2hrs) with pumped ^{3}He cryostat.

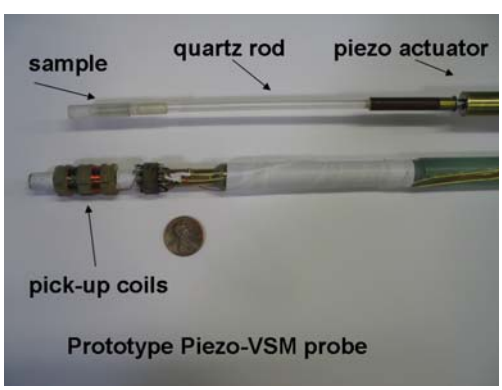

Fig. 1. Piezo-VSM probe with pick-up coils

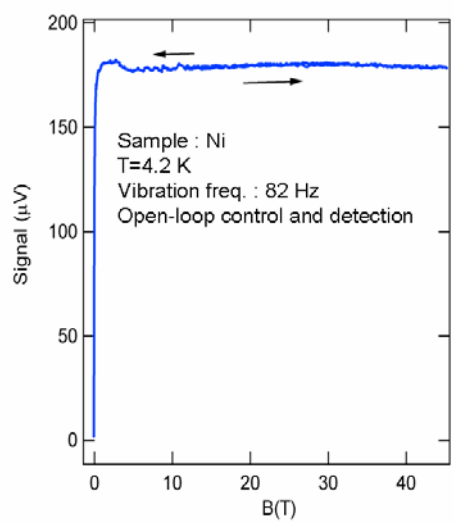

Fig. 2. The field dependence of the pick-up coil signal from a vibrating Ni sample.