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Ultrasonic measurements in the pulsed magnet

M. Yoshizawa¹, Y. Nakanishi¹, E. Muto¹, M. Oikawa¹, T. Kono², K. Nakao² and N. Kosizuka²

¹Graduate School of Frontier Materials and Functional Engineering, Iwate University, Morioka 020-8551

²Morioka Laboratory for Applied Superconductivity Technology, ISTECSRL, Morioka 020-0852

In this Skutterudite project, we will make the ultrasonic investigations in multiple extreme conditions such as high magnetic field, high pressure and low temperature. In particular, the measurements in very high magnetic field, which can do by using the pulsed magnet, is of increasing concern to the community of the strongly correlated physics. Usual sound velocity and ultrasonic attenuation measurement with a phase-comparison method, however, takes so long time to acquire data, that it is not suitable for the transient-type measurement. Therefore, we have developed the ultrasonic system for the short-time measurements in the pulsed magnetic field. The pulsed magnet, which is installed in Morioka Laboratory for Applied Superconductivity Technology, provides approximately sinusoidal field trace in 7 msec with the maximum field of 35 T. We have made a specially-tuned hand-made ultrasonic apparatus. We adopt a quadrature-phase method instead of the phase-comparison one. This method enables us to make a simultaneous sound velocity and attenuation measurements in very short time scale. We can obtain approx. 200 data in one field scan.

We will show the result of Pr-doped layered manganite $(\text{La}_{0.4}\text{Pr}_{0.6})_{1.2}\text{Sr}_{1.8}\text{Mn}_2\text{O}_7$ as an example for the high-field ultrasonic measurement. It undergoes a field-induced insulator-to-metal (I-M) transition at low temperatures. Figure 1(a) shows the time dependence of the magnetic field and the phase signals V_{0° and V_{90° , whose phase differ from 0° and 90° from the reference. Figure 1(b) is the elastic constant change $\Delta C/C$ and ultrasonic attenuation β as a function of the field. Sound velocity and ultrasonic attenuation show interesting field dependence associated with I-M transition and even in metallic phase. The results acquired in the short time scale are somewhat different from those carried out in the static field. It is the reflection of dynamical behavior near I-M transition of this system.

We are preparing to apply this system for the Skutterudite compounds.

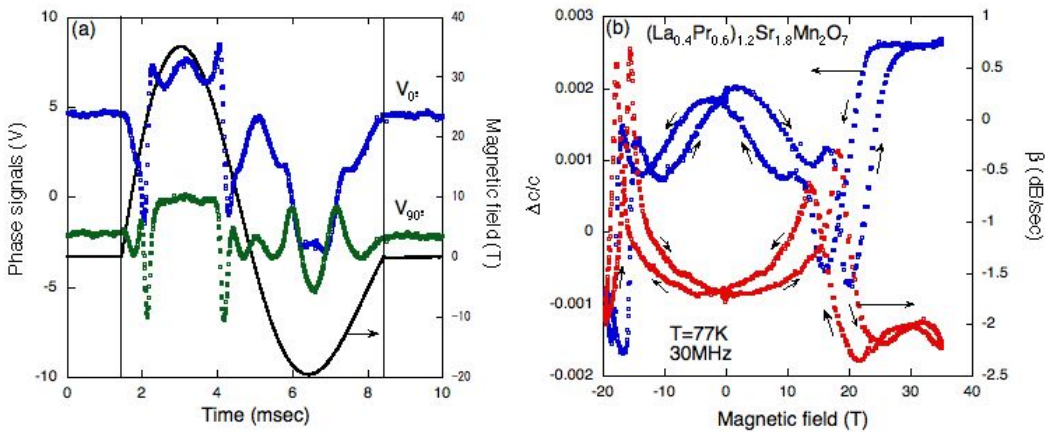


Figure 1: (a) Magnetic field and the phase signals as a function of the elapsed time, and (b) the calculated elastic constant change $\Delta C/C$ and the attenuation β as a function of the field.