

Design of pressure cell for magnetization measurement.

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Abstract

In this work we present two piston-type pressure cells to be used for magnetization measurements in commercial *Quantum Design's* magnetometers. Both cells have pressure capacity of 2 GPa and were made out of a Copper-Beryllium alloy (ASTM C17200). The first cell has the appropriate dimensions¹ to be used in a *SQUID* (*Superconducting Quantum Interference Device*) and the second one has reduced dimensions to be used in a *PPMS®* (*Physical Properties Measurement System*). Lead samples were used to properly characterize the pressure figures of both cells, as its superconducting temperature (T_c) is dependent of the applied pressure. Also the susceptibility curves of the cells as a function of temperature are shown for different pressures.

Key words: pressure, cell, magnetization.

Introduction

Intermetallic compounds usually have its physical properties dependent on external parameters such as temperature, magnetic field and pressure. Since commercial equipment like the *PPMS®* or the *SQUID* already provides a safe and trustworthy environment to use temperature and magnetic field as variables, the construction of a pressure cell to be used with them is very desirable. The design of the cells presented on this work was focused on eliminating the flaws of the two cells previously developed in the laboratory.

Results and Discussion

Up to this point only the mini cell was used in measurements in the *PPMS®*. The assembly process of the cell is relatively simple. The sample – Pb – is placed in a *Teflon®* capsule filled with mineral oil which is then placed into the pressure cell body followed by the piston and the locking nut. As the locking nut is screwed, the *Teflon®* capsule is pressed by the piston and the mineral oil transmits the pressure to the sample.

In a magnetization vs. temperature measurement one can identify the superconducting transition as a pressure dependent property of lead². The temperature dependence of the pressure is given by the equation

$$P(\text{GPa}) = \frac{T_c(0) - T_c(K)}{0.365}$$

where $T_c(0) = 7.14$ K is the superconducting transition temperature of lead under zero pressure.

In the following image one can see the superconducting transition in around 6.8 K which reveals a pressure value of 0.93 GPa.

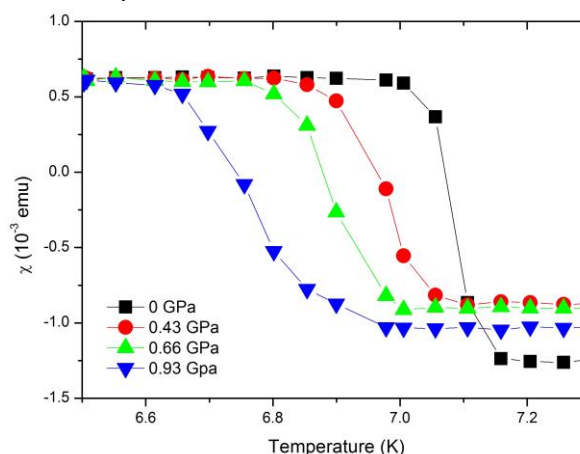


Image 1. Magnetic susceptibility by temperature in a lead sample under pressure.

Conclusions

The cell was properly designed and built to fit in a *PPMS®* and magnetic measurements were made to assure its functionality. Lead was used as a manometer and one can see a variation of its superconducting temperature T_c of about 0.34 K, which represents a pressure of 0.93 GPa. Although the cell was able to achieve the desired pressure the locking nut broke after the measurements presented above. Adjustments in its dimensions are being made to strengthen it.

Acknowledgement

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