THE LOW TEMPERATURE MAGNETIC PROPERTIES OF GLASSY AND
CRystALLINE Pd$_{0.775}$Cu$_{0.06}$Si$_{0.165}$

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Since Klement et al. prepared the first metallic glass*, there has been much interest in the properties of these new materials; magnetic properties receiving particular atten-
tion. Glass formation in the binary palladium-silicon system was first observed by Duwez et al. and Chen and Turnbull reported that small additions of noble metals to the binary Pd-Si alloys greatly enhanced glass formation and stability. The composition Pd$_{0.775}$Cu$_{0.06}$Si$_{0.165}$ is a particularly stable glass, and recently the low temperature specific heats of glassy and polycrystalline materials of this composition have been reported. In this note we present the results of our investigations on the low temperature magnetic properties of glassy and polycrystalline Pd$_{0.775}$Cu$_{0.06}$Si$_{0.165}$. The purity of our starting materials, sample preparation, and crystallization procedure duplicate that used by Golding et al. for their specific heat measurements, and differ in all three aspects from that used by Chen and Haemmerle.

A melt was prepared from elements whose purities were 5-9's or better. The reaction (to form the melt) and subsequent homogenization were done under vacuum in a quartz container at a temperature of 1373°K. The glass was then

*We use the definition of a glass as an amorphous solid obtained by cooling the liquid.
obtained by rapidly quenching this melt (contained in a quartz capillary under vacuum) into ice water. The resulting sample was a rod approximately 1 mm in diameter and .5 gm in mass. As prepared, the glass exhibited an amorphous x-ray diffraction pattern; and a calorimetric examination of a small piece of the sample indicated a glass transition at 643°K and crystallization at 683°K (20°K/min calorimetric scanning rate) which is consistent with previous work.12

The metal glass sample (~.5 gm) was placed in an ultrapure quartz container (4 mm inside diameter), alternately evacuated and back filled with helium several times, and finally sealed with an internal helium pressure of 100 torr to provide good thermal contact. The Faraday method was used to measure the temperature dependence of the magnetic susceptibility down to 1.6°K. The magnetic field for these temperature scans was constant at 12.8 kG. In addition, at room temperature the sample susceptibility was measured as a function of field between 12.8 and 2.5 kG (8 data points) and found to be field independent. This field independence indicates that the sample was not contaminated by ferromagnetic material.15

After the completion of magnetic measurements on the glass, it was crystallized by heat treating in situ for 16 minutes at 673°K; transformation kinetic studies having indicated that the material is in its first metastable crystalline state after such a treatment.16 Susceptibility vs temperature measurements were then made on the polycrystalline sample. Again, the susceptibility was field independent at room temperature insuring that the sample had not become ferromagnetically contaminated during treatment.

Finally, the sample container was opened, the polycrystal removed, and the contribution of the empty container measured. The sample susceptibilities are the measured values minus the container contribution. The container was so constructed that its contribution was less than 50% of the total measured value. From the repeatability of our measurements and the use of several known calibration standards (including single crystal Ge, liquid Hg, polycrystal In, chrome alum, and pyridine) we conclude that our accuracy is 3%.

An x-ray diffraction pattern of our polycrystalline sample (metastable) is the same as that reported by Röschel