

Figure 1 Block diagram of the analyser

Therefore a new method was developed, which applied a commercial multichannel analyser (Toshiba 400ch EDS-34802) to obtain the digital data of a line profile. The block diagram of the analyser is shown in figure 1. Dead time for channel change is less than $0.3 \mu\text{s}$. The output of the scintillation detector of a diffractometer was connected to the input of the multichannel analyser. A starter which operated the goniometer and the multichannel analyser simultaneously was prepared, with which a profile was measured repeatedly from the same angular position even on rapid scanning. The angular interval of data was suitably determined by a time constant of the multichannel analyser and scanning speed of the goniometer according to the breadth of the profile.

A profile of (100) of low crystalline α -quartz (agate) was measured on the diffractometer. The run was made with Ni-filtered $\text{Cu-K}\alpha$ at $\frac{1}{4}^\circ 2\theta$ per minute using a time constant of the multichannel analyser of 5 s. 400 channels of the multichannel analyser were divided into two parts by a region selector. A profile was divided into 200 parts, and 200 channel intensities upon a profile were memorized in the multichannel analyser. The background intensities were memorized in the rest of 200 channels and eliminated by a data processor, and

200 channel intensities were printed out. The run by step scanning was made with fixed time of 20 s at the interval of $0.02^\circ 2\theta$ in order to compare the two methods. The normalized Fourier coefficients of the profile were computed with these data and plotted against the direct distance (\AA) as the usual line broadening analysis. The results agreed very well with each other as shown in figure 2.

With this new method, the digital data of diffracted line profiles can be obtained as accurately as with step scanning and as rapidly as recording on strip charts with ordinary scanning. Since the multichannel analyser can punch out the data on magnetic or paper tapes through interface, off-line data computation may easily be performed. It is also suggested that this new method may be applied to collect the data of the radial distribution function analysis used for amorphous materials. In addition, the multichannel analyser can be connected with an attachment to any kind of diffractometer.

Reference

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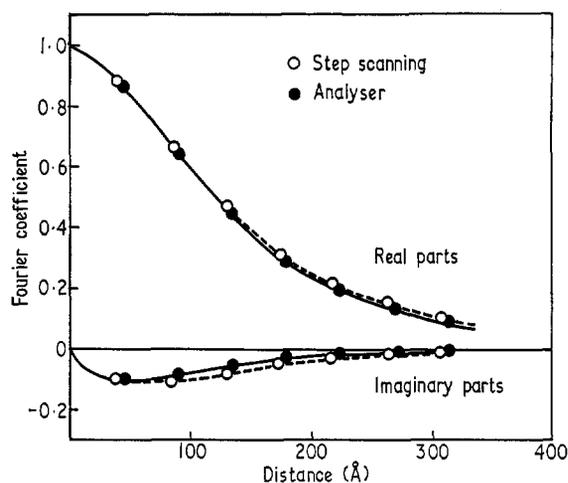


Figure 2 The Fourier coefficients of (100) of agate

Radiation-insensitive amorphous alloy resistance thermometer for low temperature

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Abstract An amorphous alloy resistance thermometer for low temperature is described, which should have good resistance to damage by radiation. The sensitivity of this metallic thermometer increases with decreasing temperature. At 50 K and 10 K, its temperature coefficients of resistivity $d\rho/dT$ are -0.024 and $-0.053 \mu\Omega \text{ cm}^{-1} \text{ K}^{-1}$ respectively.

1 Introduction

The measurement of temperature with metallic resistance thermometers such as platinum, or with thermocouples (e.g. Au Co against Cu) becomes increasingly difficult below approx. 40 K, due to their diminishing sensitivity. The semiconductor resistance thermometer exhibits a large negative temperature coefficient at low temperatures and is therefore very useful in the liquid He temperature range. However, semiconductor thermometers become increasingly insensitive above approx. 30 K. Furthermore, all these temperature measuring devices are damaged when used in a high level radiation environment.

2 The amorphous alloy and its electrical properties

In this paper we describe a radiation-resistant amorphous alloy resistance thermometer that can cover a wide temperature range (~ 1.5 to 300 K) with a sensitivity increasing with decreasing temperature. The amorphous alloys of the general composition $\text{Cr}_x\text{Pd}_{80-x}\text{Si}_{20}$ where $0 < x \leq 7$, are obtained by rapidly quenching the alloy from the liquid state following a technique described previously (Pietrokosky 1962). The specimens thus obtained are foils about 2.5 cm in diameter and 40 μm thick. A well defined minimum in the resistivity against temperature curve is observed for all these amorphous alloys (Tsuei and Hawegawa 1969). This anomalous temperature dependence of resistivity has been attributed to a Kondo-type s-d exchange scattering. The resistivity minimum temperature T_m was found to be approximately linearly proportional to the Cr concentration x . When x is equal to 7, the resistivity minimum temperature T_m is as high as 500 K. The resistivity $\rho(T)$ and its temperature coefficient $d\rho(T)/dT$ of a typical amorphous alloy $\text{Cr}_7\text{Pd}_{73}\text{Si}_{20}$ are shown in figure 1. Because of their unusual temperature dependence of resistivity and their large T_m these alloys should be useful as low temperature thermometers. The amorphous alloy resistance thermometer can be made by die cutting the rapidly quenched foils into an appropriate shape which would give sufficient voltage output. The details of the construction of the actual thermometer are essentially the same as those of standard metallic thermometers. The following sensitivity can be easily achieved for the $\text{Cr}_7\text{Pd}_{73}\text{Si}_{20}$ alloy: 48 $\mu\text{V K}^{-1}$ at 20 K, 60 $\mu\text{V K}^{-1}$ at 10 K with 2 mA current.

3 Main characteristics of the thermometer

The amorphous resistance thermometer has the following features:

1 The resistance of the amorphous alloy should not be sensitive to radiation. According to the work of Lesueur (1968),

amorphous alloy $\text{Pd}_{80}\text{Si}_{20}$ (which is essentially the same as the amorphous $\text{Cr}_7\text{Pd}_{73}\text{Si}_{20}$ alloys) shows no appreciable change in the x-ray diffraction pattern nor in the resistivity values, when it is coated with ^{235}U and is exposed to a flux of thermal neutrons of approx. $10^{13} \text{ n cm}^{-2} \text{ s}^{-1}$ at a temperature of less than 100°C . The sample receives about 10^{13} fission products per square centimetre. Therefore, the amorphous alloy resistance thermometer should have good resistance to damage by radiation.

2 Its temperature coefficient of resistivity increases with decreasing temperature (figure 1) and becomes larger than that of Pt for temperatures less than 40 K. If the sensitivity of a resistance thermometer is expressed as $(1/\rho)(d\rho/dT)$, the amorphous alloy thermometer is much less sensitive than a Pt thermometer except at temperatures below 10 K.

3 The temperature dependence of the resistivity can be represented within 0.01% by Hamann's theoretical expression (Hamann 1967) over a temperature range from 4 to 100 K (see insert in figure 1). Hamann's formula is

$$\rho(T) = \frac{1}{2}\rho_0 \left[1 - \frac{\ln(T/T_k)}{\{\ln^2(T/T_k) + S(S+1)\pi^2\}^{1/2}} \right] + B$$

for $\text{Cr}_7\text{Pd}_{73}\text{Si}_{20}$ alloy:

$$\begin{aligned} \rho_0 &= 8.36 \mu\Omega \text{ cm}^{-1} & T_k &= 132.2 \text{ K} \\ S &= \frac{1}{2} & B &= 136.69 \mu\Omega \text{ cm}^{-1}. \end{aligned}$$

4 The amorphous alloy crystallizes rapidly around 420°C . However, the rate of crystallization becomes appreciable only above about 250°C . Preliminary kinetics data indicate that, at room temperature, the time required for reaching half of the transformation would be about 10^8 years. The reproducibility of the (ρ, T) curve after many cyclings from liquid helium to room temperature has been found to be better than 0.1%.

Acknowledgment

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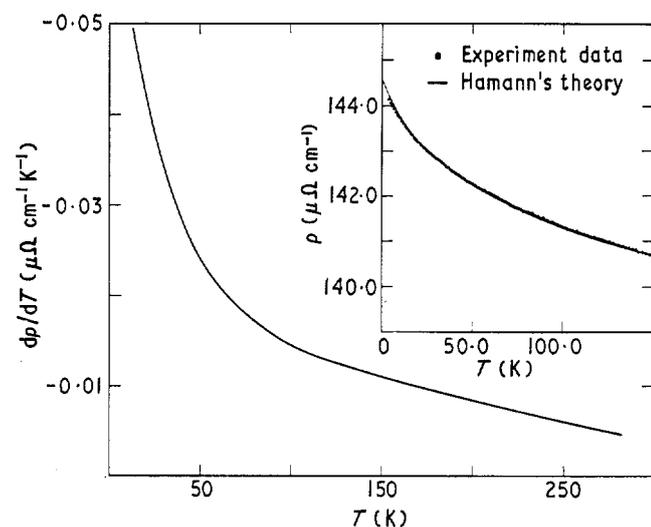


Figure 1 Resistivity $\rho(T)$ (insert) and its temperature coefficient $d\rho(T)/dT$ of amorphous alloy $\text{Cr}_7\text{Pd}_{73}\text{Si}_{20}$

A simple modification for the Ward electron microscope specimen holder

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Abstract A modification to the standard specimen holder is described by means of which tilts of up to $\pm 70^\circ$ may be obtained. The improvement consists solely of a redesigned specimen platform.

1 The modified specimen platform

Complete Burgers vector determinations of dislocations in transmission electron microscope specimens can often entail