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Bulk Gadolinium의 Curie점 결정

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The Determination of Curie Point of Bulk Gadolinium

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초 록 이 short note에서 우리는 bulk gadolinium의 강자성에서 상자성으로의 전이온도(즉, Curie점) 측정에 대한 결과를 보고하고자 한다. 이 결과보고는 gadolinium박막에 대한 이전의 결과에 정당성을 주기 위해서 쓰여졌다. 본 실험에서 bulk gadolinium의 Curie점은 시료의 저항을 온도의 함수로 측정함으로써 결정하였다. 이는 Curie점에서 비열의 특이성이 바로 비저항의 특이성으로 연결되기 때문이다. 결과적으로 우리는 bulk gadolinium의 Curie점이 19.2 ± 0.3℃가 되고 이 값은 비열의 실험치로 결정한 다른 그룹들의 실험값들과 잘 일치하고 있음을 알 수 있었다.

Abstract In this short note, we report the result of measurement for the ferro- to paramagnetic phase transition temperature, that is Curie point of bulk gadolinium. This note is written to give the solid validity for the previous measurement of Curie point shift of gadolinium film (I. Rhee, E. Lee and S. Lee, Kor. J. of Mat. Research, 3, 3, 1993). The Curie point of bulk gadolinium is determined by measuring the resistance of sample as function of temperatures. At Curie point, we can observe the resistivity anomaly which arises due to the heat capacity difference between below and above Curie point. Finally, the curie point of bulk gadolinium is found to be 19.2 ± 0.3℃.

Generally, the second order phase transition materials show the heat capacity anomaly at phase transition temperature. This phenomenon is associated with the disappearance of long range order at this temperature. For the magnetic system, Fisher and Langer[1] predicted that the resistivity anomaly would be observed in bulk ferromagnet at Curie point. This idea comes from the fact that the heat capacity might be proportional to $d\rho/dT$, where ρ and T are the resistivity of sample and the temperature, respectively.

Previously, we reported the shift of Curie point for a gadolinium film of 6600A[2]. There, we used the result of others[3~5] for the reference phase transition temperature of bulk gadolinium, which was 19℃. Now, in this note, we will present the result of this reference phase transtion temperature measurement using the same experimental set-up as before[2], to give the validity of previous measurement for the gadolinium film.

For the bulk gadolinium sample, we used a well-polished gadolinium plate of 3cm×2cm×0.5mm dimensions and 99.99% purity (JOHNSONMATTHEYCOMPANY,00118,M4N(REO)). To achieve the larger electrical resistance, this plate is carefully cut in the form of zig-zag pattern. Then, the rough edges are carefully mechanically polished. Finally, the sample is annealed at mild temperature of 400℃ for about 4 hours to *remove* the *form* crystal defor mations polishing process.

The sample is then mounted on the heating plate. The schematic arrangements for heater system are shown in Fig. 1. The bulk sample is tightly mounted on the heating plate with thin layer of insulating crystal bond. This whole

system is evacuated to less than 10^{-5} Torr during the experiment.

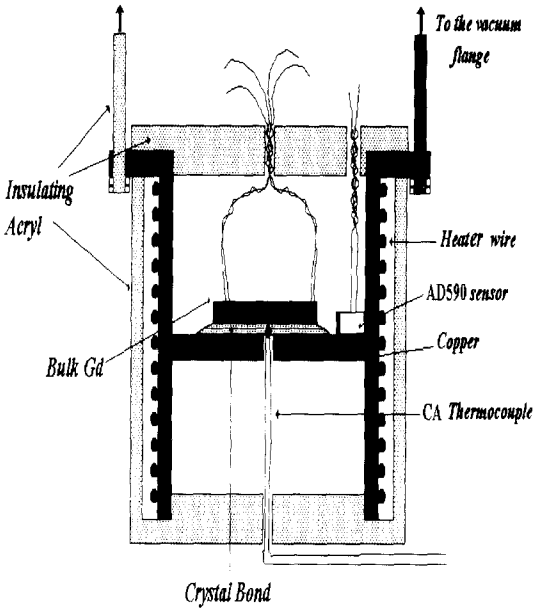

Fig. 1. The arrangements of heater system are shown in this figure. This whole system is inside the vacuum system of pressure of less than 10^{-5} Torr during the experiment.

The sample inside the vacuum system is cooled down by ice water outiside of the vacuum system. Then, the temperature is very slowly raised, typically 1m℃/sec, by electrical heating. The small changes of resistance of sample according to the changes of temperatures are measured by a slightly unbalanced resistance bridge system. Later, the validity of this technique was confirmed by dc resistivity measurements with measuring currents (10mA) provided by HP 6320 power supply of stability of 5 parts in 10^5. The emf from the CA thermocouple and the unbalanced signal from the bridge system are recorded by a two-pen strip chart recorder, model of μR180, which is equiped with the function of amplication for the thermocouple signal.

The data for bulk gadolinium sample are shown in Fig. 2. In this figure, we can see clearly the inflection of rate of resistance changes around 19℃. Here, also, the first derivatives of resistance data are shown in the inset.

From these data, the Curie point of bulk gadolinium is found to be 19.2 ± 0.3℃. Here, the error indicates the ambiguity in determining the peak position in the inset. The value of this transition temperature is consistent with the others' experimental values[3~5] from the heat capacity measurements.

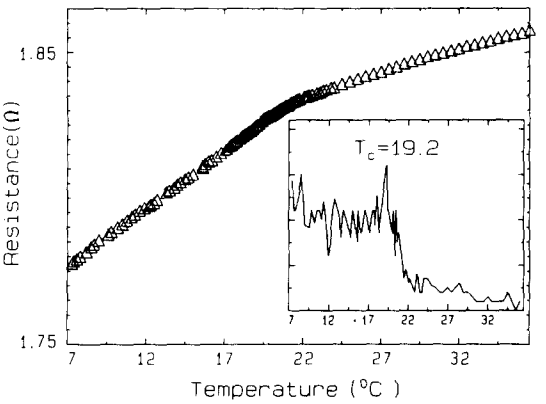

Fig. 2. The resistance data and their corresponding first derivatives(inset) are shown in this figure. The Curie point of bulk sample is determined to be 19.2 ± 0.3℃ from the inset.

Acknowledgement

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