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Letter

High-field magnetization in $PrCu_2Si_2$, $PrCu_2Ge_2$, $TbCu_2Si_2$ and $DyCu_2Si_2$ compounds

V. Ivanov and L. Vinokurova
General Physics Institute, Academy of Sciences, Vavilov Street 38, 117942 Moscow (Russian Federation)

A. Szytuła
Institute of Physics, Jagellonian University, Reymonta 4, 30-059 Kraków (Poland)

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Abstract

The magnetic properties of some RCu_2X_2 compounds were studied by measuring the high-field magnetization in magnetic fields up to 140 kOe and in the temperature range 4.2–35 K. The magnetization curves for all the RCu_2X_2 compounds show a metamagnetic character.

1. Introduction

In the last few years the RCu_2Si_2 and RCu_2Ge_2 compounds have been studied thoroughly [1–11]. Magnetometric and neutron diffraction measurements indicate an antiferromagnetic ordering at low temperatures. $PrCu_2Si_2$ and $PrCu_2Ge_2$ have a simple antiferromagnetic ordering of the AFI type [10] with the wave vector $k=(0, 0, 1)$. The magnetic moments of praseodymium atoms form ferromagnetic (001) planes. The magnetic structure can be displayed as a piling up of the ferromagnetic sheets along the c-axis with the sequence $+-+-$ etc. $TbCu_2Si_2$ [9, 11] and $DyCu_2Si_2$ [8] have an antiferromagnetic ordering of the AFIV type with the wave vector $k=(\frac{1}{2}, 0, \frac{1}{2})$. The magnetic ordering may be described as ferromagnetic (101) planes of R^{3+} ions coupled antiferromagnetically with the sequence $+-+-$ etc. This structure has doubled a and c dimensions of the unit cell. The magnetic moments are perpendicular to the c-axis.

In this work the results of high-field magnetization measurements of $PrCu_2Si_2$, $PrCu_2Ge_2$, $TbCu_2Si_2$ and $DyCu_2Si_2$ compounds are reported.

2. Experiments and results

Experiments were carried out on polycrystalline samples as reported in previous papers [10, 11].

The magnetization curves for polycrystalline samples at different temperatures in a magnetic field up to 140 kOe are presented below.

2.1. $PrCu_2Si_2$ and $PrCu_2Ge_2$

Magnetization curves obtained at $T=4.2$ K exhibit a one-step metamagnetic process (see Fig. 1) with a critical field of 35 kOe for $PrCu_2Si_2$ and 15 kOe for $PrCu_2Ge_2$. Increasing the temperature causes a decrease in the values of critical field. The values of magnetic moment at $T=4.2$ K and $H=140$ kOe are $1.5\mu_B$ for

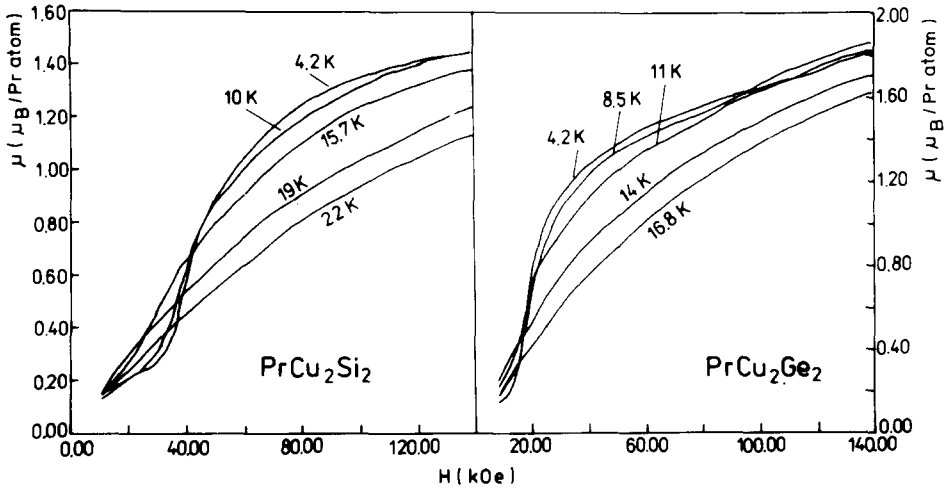

Fig. 1. High-field magnetization curves at different temperatures for $PrCu_2Si_2$ and $PrCu_2Ge_2$.

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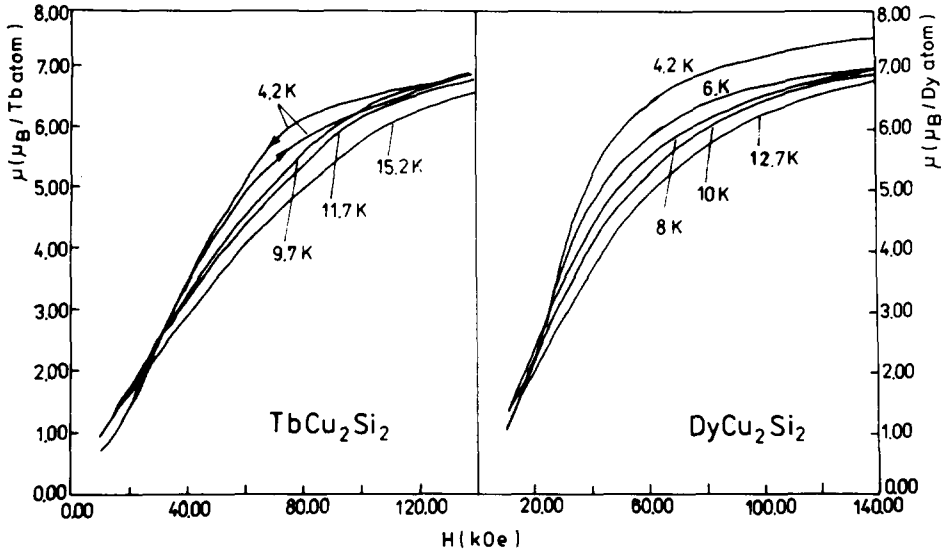

Fig. 2. High-field magnetization curves at different temperatures for $TbCu_2Si_2$ and $DyCu_2Si_2$.

$PrCu_2Si_2$ and $1.9\mu_B$ for $PrCu_2Ge_2$; they are smaller than that observed for a free Pr^{3+} ion ($gJ=3.27\mu_B$).

2.2. *$TbCu_2Si_2$ and $DyCu_2Si_2$*

The variation of magnetization as a function of the external magnetic field at different temperatures is shown in Fig. 2. The dependences of the magnetizations on magnetic field have no anomalies. The magnetization increases linearly with increasing magnetic field up to 25 kOe for $TbCu_2Si_2$ and up to 15 kOe for $DyCu_2Si_2$. The values of magnetization at $H=140$ kOe and $T=4.2$ K are $7.0\mu_B$ per terbium atom for $TbCu_2Si_2$ and $7.5\mu_B$ per dysprosium atom for $DyCu_2Si_2$. These values are smaller than those expected for the free R^{3+} ions.

The magnetization curves for all RCu_2X_2 compounds have a metamagnetic character. The values of the critical fields decrease with increasing number of f-electrons. The critical field for $PrCu_2Ge_2$ is smaller than that observed in the isostructural $PrCu_2Si_2$. This dependence is also observed in the isostructural RCo_2X_2 compounds [12]; however, the values of critical field in RCu_2X_2 are smaller than those observed for RCo_2X_2.

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