Incommensurate magnetic structure in $Y_{(1-x)}Tb_xMn_6Sn_6$.

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We have investigated the magnetic structure in the intermetallic compounds $Tb_xY_{1-x}Mn_6Sn_6$ ($0 \leq x \leq 0.25$) by means of small angle neutron scattering (SANS). In such intermetallic materials the competition between different exchange interactions results in a variety of the magnetic structures and properties. Thus, giant magnetoresistance was recently found in this type of materials [1].

The YMn_6Sn_6 is a compound crystallized in hexagonal $HfFe_6Ge_6$-type structure (space group P6/mmm) [2]. The lattice has an intrinsically layered structure, where Mn atoms are organized in a so-called "kagome" lattice within the ab planes, which are stacked along the c axis with Y and Sn_3 atomic planes between them. The Mn-Mn interplane distance through Sn_3 atomic plane is slightly larger than that through Y atomic plane. Below the Neel temperature T_N=333K the YMn_6Sn_6 compound has an incommensurate periodic structure [3]. It is believed that spins are ordered in the helix along the c axis similar to a simple planar helimagnet [4].

To make clear a role of different exchange interactions we studied samples where Y is partially substituted by Tb. The substitution of magnetic Tb for Y in the $Tb_xY_{1-x}Mn_6Sn_6$ compounds changes the magnetic ordering type from incommensurate antiferromagnetic to ferrimagnetic at the concentration $x \approx 0.2$. The ferrimagnets at $x > 0.2$ show a change of the magnetocrystalline anisotropy with increase of temperature from an easy-axis type to an easy-plane type through a conical phase [5].

The use of SANS allows one to observe large-scale magnetic ordering modes. Two scattering contributions are well distinguished. The first one is a diffraction peak, which originates from the scattering on the magnetic long periodic structure. The second one is a small angle scattering attributed to the magnetic inhomogeneities such as domains or critical spin fluctuations. The period of the magnetic structure calculated from diffraction peak position for T= 175K is d_{TB0}=3.76 nm for YMn_6Sn_6 and is $d_{TB.2}$=7.06 nm for $Tb_{0.2}Y_{0.8}Mn_6Sn_6$. Coherent lengths of magnetic structure are w_{TB0}=17 nm and $w_{TB.2}$=28 nm. Experimental data suggest that the temperature behavior of the magnetic structure for YMn_6Sn_6 is very different from that for the simple planar helimagnet of Ho or Dy- type [4]. The temperature evolution of the magnetic structure for samples with Tb- substitution is even more complex. The c-T phase diagram is obtained on the basis of SANS measurements.

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