Ferromagnetic and structural properties of $Ge_{1-x}Mn_xTe$ epitaxial layers

W. Knoff, P. Dziawa, V. Osinniy, B. Taliashvili, W. Domuchowski, R. Diduszko, J. Domagała, E. Łusakowska, R. Jakieła, and T. Story

Institute of Physics, Polish Academy of Sciences, Lotników 32/46, 02-668 Warsaw, Poland

$Ge_{1-x}Mn_xTe$ belongs to the family of IV-VI semimagnetic (diluted magnetic) semiconductors which exhibit carrier concentration induced ferromagnetic transition. Structural (ferroelectric) transition from the rock salt structure (at high temperatures) to the rhombohedral structure (at low temperatures) is also observed in bulk crystals of GeMnTe. In this work, we experimentally study the structural and ferromagnetic properties of the epitaxial layers of $Ge_{1-x}Mn_xTe$ with varying Mn composition and conducting hole concentration.

Monocrystalline layers of $Ge_{1-x}Mn_xTe$ ($x<0.2$) were grown on BaF_2 (111) substrates by molecular beam epitaxy technique employing effusion cells for GeTe, Mn and Te. Chemical composition and homogeneity as well as crystal structure and surface morphology of the layers were examined by SIMS, energy dispersive X-ray fluorescence, X-ray diffraction and AFM microscopy techniques.

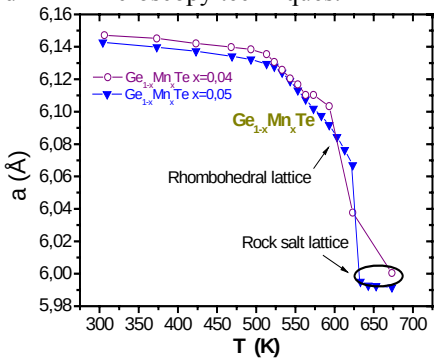

Fig .1. Temperature dependence of lattice parameter of $Ge_{1x}Mn_xTe$ layers.

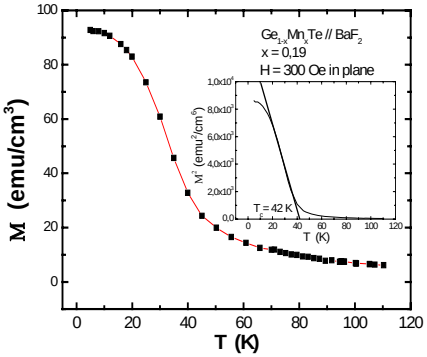

Fig .2. Temperature dependence of magnetization for $Ge_{1-x}Mn_xTe$ ($x=0.19$) 0.25 μm thick layer.

For the experimental determination of the structural transition temperature, the high resolution X-ray diffraction measurements were performed in the temperature range T=300 – 700 K, revealing the structural transition in $Ge_{1-x}Mn_xTe$ layers with x=0.04 and 0.05 at T=625-675 K (Fig. 1.). The examination of the magnetic properties of the layers was carried out in the temperature range T=4.5-200 K by superconducting SQUID magnetometer and revealed the ferromagnetic transition with the Curie temperature T_c<100 K. It was experimentally observed that the temperature dependence of the magnetization M(T) strongly varies for layers with different carrier concentration. The mean-field like dependence is observed only in layers with very high hole concentration (Fig. 2.).

Name of the presenting author (poster session II): Wojciech Knoff
e-mail address: knoff@ifpan.edu.pl
http://www.ifpan.edu.pl