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Abstract

The main objective of this study is to investigate the local structural and magnetic properties of thin epitaxial films of Mn_5Ge_3 as well as carbon-doped epitaxial films of $Mn_5Ge_3C_x$. Mn_5Ge_3 is a metallic ferromagnet crystallizing in hexagonal structure (space group $P6_3/mcm$). It is a new prospective spintronic material, a potential source of spin polarized carriers into Ge. This is due to the high spin polarization of the conduction electrons, compatibility with conventional Si/Ge electronics and high Curie temperature that can be further increased up to 430 K by adding a small amount of carbon. Another possible route of exploitation of this material is related to its strong uniaxial anisotropy, leading to potential applications in both, emerging spintronics and next-generation data storage technologies.

A strong modification of the material properties as a result of carbon-doping, in particular a considerable drop of the uniaxial magnetocrystalline anisotropy that regrettably goes along with the benefit of increasing the Curie temperature, raised the question as to the role played by carbon in this system. The main idea of this study is based on probing the local magnetic properties by means of ^{55}Mn NMR spectroscopy. A complementary FMR study has also been performed, supported by the OOMMF calculations, aimed at understanding the domain structure as a function of the film thickness and determination of the anisotropy constant as a function of carbon concentration.

One of the main results of this study was a demonstration of significant anisotropy of hyperfine fields on ^{55}Mn nuclei in epitaxial films of Mn_5Ge_3. In the two Mn crystallographic sites of Mn_5Ge_3 structure: 4(d) and 6(g), a significant difference of hyperfine field strengths was found between the hexagonal *c*-direction and the *c*-plane. Moreover, it was found that in the 6(g) sites the magnitude of hyperfine field difference between the *c*-plane and the *c*-direction is strongly modulated due to the presence of an additional six-fold anisotropy in the *c*-plane. The observed anisotropy of hyperfine fields was attributed to the anisotropic orbital term due to the unquenched orbital momentum of Mn. It was proposed that the difference between the orbital momentum along the *c*-axis and that in the *c*-plane is also the most

probable source of the observed uniaxial magnetocrystalline anisotropy in this compound, and accounts for the formation of the stripe domain structure in films thicker than 20 nm.

The carbon-induced modification of ^{55}Mn hyperfine field distribution indicates that carbon enters as a nearest neighbor of Mn in the 6(g) position, confirming that it occupies the interstitial voids 2(b) in this structure. It was found that the presence of carbon dopant changes locally the magnetic moment on the neighboring Mn atoms and lowers the anisotropy of hyperfine fields in the two crystallographic sites of Mn. The decreased anisotropy of hyperfine fields may in turn account for the decreased uniaxial magnetocrystalline anisotropy observed in the macroscopic experiment of FMR.

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