Magnetic order, magnon confinement and propagation in MnTe/ZnTe superlattices

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MnTe with the zinc blende (ZB) structure, obtained with the use of non-equilibrium growth techniques, such as MBE, exhibit an antiferromagnetic (AF) order of type-III at low temperatures (Néel temperature of about 65 K). This kind of magnetic order persists also in MnTe layers in MnTe/ZnTe superlattices (SLs). Because of the distortion of the *fcc* lattice an energy-minimizing magnetic configuration with the unit cell doubling direction along the SL growth axis is realized in such structures. The presence of an interlayer exchange coupling has been reported for selected MnTe/ZnTe SLs previously [1,2] but details of this coupling and an anomalous temperature behavior of features observed by the neutron diffraction were not fully understood. The goal of the current research was to gain more information on the magnetic properties of various SLs mentioned above.

Several MBE-grown, MnTe/ZnTe short period SLs with various numbers of monolayers in magnetic and non-magnetic slabs were analyzed by elastic and inelastic neutron scattering. The first method demonstrated a magnetic coherence in selected SLs for a distance as high as 900 Å at low temperatures. The temperature behavior of spectra observed in our experiments was found to be quite different from that previously reported in the literature. Possible physical mechanisms responsible for observed magnetic correlation in AF-ordered MnTe layers of these SLs are discussed.

In our earlier studies we have determined the collective magnetic excitations (magnons) dispersion in quasi-bulk ZB-MnTe slab at low temperature (in AF-III phase) by inelastic neutron scattering [3]. In current research we have observed not only a long-range coherency between AF layers for ZnTe spacer thickness up to ~25 Å, but also the propagation of collective magnetic excitations (magnons) along the SL-stacking direction in short-period SLs. For large enough ZnTe spacers, on the other hand, the AF MnTe layers are no longer correlated and size quantization effects (confinement) for magnons take place. An experimental evidence of both effects was found in our inelastic neutron scattering measurements, performed with the use of thermal and cold neutron beams. A similarity of theoretically predicted and experimentally observed magnon spectra was also shown. To the best of our knowledge presented results constitute the first clear evidence of magnon propagation and magnon confinement in magnetic SLs that was demonstrated with the use of inelastic neutron scattering technique.

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