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Microscopic observation of MnAs/GaAs(001) in varying magnetic field

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Epitaxial MnAs on GaAs is one of the promising ferromagnetic/semiconductor hybrid systems for future spintronic applications. Two structurally distinct elastic domains (ferromagnetic hexagonal α-MnAs and paramagnetic orthorhombic β-MnAs), in the form of self-organized periodic array of stripes of the two elastic domains, are known to coexist via strain-stabilization. It is necessary to understand the micromagnetic structure which is closely related to the microstructure. However, the previous studies concerned the observation of micromagnetic structures, and the behavior of magnetic domain structures in an external magnetic field has not been analytically investigated yet. In this work, the effects of external magnetic field were studied, on the magnetic domain structure and the magnetic properties of epitaxial MnAs films on GaAs. A MnAs film of 250 nm thick was epitaxially grown on a GaAs(001) substrate in a molecular-beam epitaxy system. The atomic force microscopy (AFM) and the magnetic force microscopy (MFM) images were obtained at room temperature. It is found that a complex magnetic domain structure appears in the ferromagnetic α-phase region at the demagnetized state (H = 0), that is, the zig-zag patterned domain wall (DW), separating two domains, exists in the center of the stripe. As the magnetic field increases, the complex magnetic domain structure is changed, and then reach a completely saturated state only with directed domains at H = 600 Oe. Especially, at H = 300 Oe, the observed magnetic DW distribution is well matched with the topological one, which reveals that the anisotropy, induced by the topological shape of α-phase, influences the magnetic DW structure of α-phase.