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Abstract

Static and dynamic properties of domain walls in magnetic multilayers are theoretically studied. The case of wall perpendicular to the magnetic layers plane are considered. It is found eight exact static solutions corresponding to the various types of domain walls in multilayers. Some of them have no analogue in usual magnet. The nonlinear equations of the dynamics of the magnetization for the antiferromagnetic exchange interaction between magnetic layers are derived. The domain wall dynamics is studied in two different approximations: a strong exchange approximation and a strong demagnetization energy.

The various properties of magnetic multilayer structures are bound to attract the attention. These materials are interesting both from fundamental and applied point of view due to the promising perspectives of their use in memory devices.

The magnetization reversal process and field-induced phase transitions in magnetic multilayers are being studied intensively (see e. g. [1] and references therein. It has been reported that domain wall structure has a pronounced effect on magnetization reversal process in magnetic superlattices [2, 3, 4] In particular, it can change the resistive properties of magnetic superlattice. But resistive characteristics can be affected by domain wall structure too. Domain walls in magnetic multilayers have many interesting properties (such as asymmetry of domain wall, the departure of the magnetization from the plane of layers and so on) as shown in [5]. It is also established in [6] that symmetric domain walls in magnetic superlattices become unstable under the certain conditions.

By the present time the domain wall structure in magnetic superlattices are theoretically poorly investigated. In particular, the domain wall structure in magnetic multilayers with noncollinear orientation of magnetization in adjacent layers have not been studied though the existence of such domain walls are experimentally established [2, 3, 4]. In present work the theoretical investigation of the domain wall structure in magnetic multilayers with uniaxial anisotropy are made. The biquadratic exchange interaction are taking into account. Both collinear and noncollinear orientation of magnetization in adjacent layers are considered. The investigation of the domain wall structure was made in two-sublattice approximation. It is supposed that magnetization in all odd layers is equal to $\vec{M}_1$ and in all even layers is equal to $\vec{M}_2$. This approximation is valid for small layers number [7] and breaks down at surface spin-flop transition [8]. It is supposed that the width of each magnetic layer is much less than domain wall width ($d \ll \Delta$). Let us assume that z axis is directed perpendicular to the layers plane. In that case the magnetization dependence from coordinate z is neglected. In this instance the problem of calculation the dependence $\vec{M}(x, y, z, t)$ from three coordinate reduces to the problem of calculation the dependencies $\vec{M}_1(x, y)$ and $\vec{M}_2(x, y)$ from two coordinates, where $\vec{M}_i$ is the magnetization in the i-th sublattice. In studies of domain wall structure in such two-sublattice approximation we start from the variational principle

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