SWR studies of higher-order surface anisotropy terms in (Ga,Mn)As thin films

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We have recently [1] extended the theory of spin-wave resonance (SWR) by deriving a new formula representing the surface pinning parameter $A = A(\varphi, \vartheta)$ as a series of contributions from anisotropies assumed to occur in (Ga,Mn)As thin films (see Eq. (3.13) in [1]). The pinning coefficients in this equation corespond to different anisotropies: a_{c1}, a_{c2} and a_{c3} are related to the first-, second- and third-order cubic anisotropies, respectively; $a_{[001]_1}$ and $a_{[001]_2}$ to the first- and second-order perpendicular uniaxial anisotropies, respectively; $a_{[100]}$ and $a_{[110]}$ to the respective in-plane uniaxial anisotropies; ϑ and φ denote the spherical magnetization angles. Here, we compare the theoretical predictions with the experimental data obtained in the SWR study of (Ga,Mn)As films reported in [2], to find that, except for the $a_{[100]}$ uniaxial anisotropy, all the anisotropies taken into account in [1] indeed occur on the surface of a (Ga,Mn)As thin film. To our best knowledge this is the first report of the existence of higher-order surface anisotropy fields in this material.

References:

[1] H. Puszkarski, P. Tomczak and H. T. Diep, Phys. Rev. B **94**. 195303 (2016).
[2] X. Liu, Y.-Y. Zhou, and J. K. Furdyna, Phys. Rev. B **75**, 195220 (2007).