Hexagonal MnBi islands with tunable magnetic anisotropy

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Permanent micro- and nano- magnets find application in devices such as biological probing and MEMS [1]. However, their fabrication typically includes complex processing (e.g. lithography). MnBi is an intermetallic ferromagnetic alloy with good permanent magnet properties such as a high magnetocrystalline anisotropy of 1.6 MJ/m^3 at room temperature and a relatively high $(BH)_{max}$ of 20 MGOe. On top of that, MnBi shows a high Curie temperature of 711 K and an unusual positive temperature coefficient of the coercivity [2-4], which makes it an attractive rare earth-free alternative for high temperature applications.

In this study, a one-step route has allowed for the fabrication of highly crystalline hexagonal MnBi islands (thickness varying from 200 nm to 2.1 µm and lateral dimension of 30 µm), by RF-sputtering of a composite target onto glass substrates at different deposition temperatures (T_D) [4]. A strong impact of T_D on the magnetic properties has been proven. Specifically, magnetic anisotropy could be tuned from out-of-plane ($T_D < 375$ K) to in-plane ($T_D = 475$ K), with no need of an external magnetic field during deposition.

High values of coercivity have been obtained: 13.1 kOe at 400 K along the out-of-plane direction ($T_D = 375$ K) and 14.1 kOe at 400 K along the in-plane direction ($T_D = 475$ K). MFM study has allowed observing a strong perpendicular anisotropy in these islands, which show a hexagonal crater-like shape (Fig. 1). The periodicity of the stripe domains obeys the D = 1.18 * sqrt (T) law in good agreement with theoretical predictions. The dependency of D *vs* T in MnBi thin films reported in literature over the years has been validated through the MFM study of the crater-like shape MnBi islands [4]. Moreover, this study has allowed us to extend the dependency of D *vs* T for MnBi in a thickness range well beyond previously published results, thus advancing in the comprehension of the MnBi system.

References

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Figures

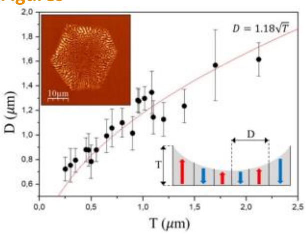

Figure 1: Dependence of domain width (D/2) on the thickness (T) of the islands from MFM images (inset). The D = 1.18 * sqrt (T) law is obtained by fitting the data points (red line).

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