

# Magnetization process and magnetic anisotropy of $\text{Ga}_{1-x}\text{Mn}_x\text{As}$ on GaAs (311)A substrate

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We have studied magnetization processes and magnetic anisotropy of  $\text{Ga}_{0.94}\text{Mn}_{0.06}\text{As}$  thin film grown by low-temperature molecular beam epitaxy on GaAs (311)A substrates by means of superconducting quantum interference device (SQUID) and magneto-optic microscopy. The magnetization curve obtained by SQUID are explained phenomenologically using two main contributions to the magnetic anisotropy: a cubic magnetocrystalline anisotropy with easy  $\langle 001 \rangle$  axes, and an effective uniaxial magnetic anisotropy with hard axis along  $[311]$  caused by the epitaxial compressive strain from the substrate. We find the uniaxial anisotropy constant to depend linearly on  $M_S^2$  and the cubic anisotropy constant to follow  $M_S^4$  (here  $M_S$  is saturation magnetisation), confirming the validity of the single domain model used to describe magnetization rotations in this material. Our results are in agreement with ferromagnetic resonance data<sup>1</sup> and expectation of the p-d Zener model of the carried mediated ferromagnetism<sup>2</sup>.

1. C. Bihler, et. all *Appl. Phys. Lett.* **89**, 012507 (2006).

2. T. Dietl, H. Ohno, F. Matsukura, *Phys. Rev. B*, **63**, 195205 (2001).

13.4 cm

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9.7 cm