Fe_5GeTe_2 van der Waals Ferromagnet grown by Molecular Beam Epitaxy

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Among magnetic van der Waals (vdW) materials, layered Fe-Ge-Te compounds stand out due to their itinerant ferromagnetism and Curie temperature (T_C) above 200K [1,2]. They host noticeable magnetic effects such as a large anomalous Hall effect of topological origin [3] and magnetic skyrmions [4]. So far, Fe-Ge-Te alloys have mostly been studied in the form of flakes exfoliated from bulk crystals. However, technologically relevant applications require the ability to grow films over large areas with an accurate control of the thickness and a T_C at or above room temperature (RT).
Here, we demonstrate the large-area growth of single-crystal Fe_5GeTe_2 on insulating Al_2O_3(0001) using molecular beam epitaxy (MBE) [5]. SQUID measurements show the persistence of soft ferromagnetism up to RT, with a T_C of 293K. Structural characterization by electron diffraction, X-ray diffraction and scanning transmission electron microscopy (STEM) confirm the single-crystalline character of the films. The stoichiometric 5:2:1 Fe:Ge:Te elementary composition is ascertained by Rutherford backscattering spectroscopy (RBS). In contrast to reports on bulk crystals, virtually no Fe deficiency is observed in MBE-grown films. The orbital and spin moments determined by X-ray magnetic circular dichroism are in good agreement with our first-principle calculations. We further show that the T_C remains significantly high (240K) in 2-monolayers-thick films.
These results open important perspectives for the large-scale fabrication of high-T_C layered ferromagnets and for the realization of ultracompact vdW heterostructures.

References

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Figures

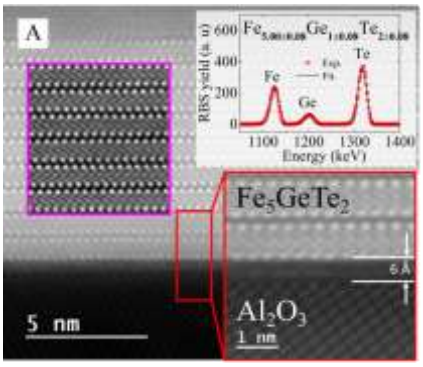

Figure 1: HAADF-STEM cross section of Fe_5GeTe_2 van der Waals ferromagnet. Inset: composition determined by Rutherford backscattering.