Magnetic and spin-transport properties of MgB_2-based and NbN-based epitaxial multilayers.

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The interplay of magnetism and superconductivity has been heavily studied the past 30 years and recently led to the concept of superconducting spintronic. Nevertheless, proximity effect, inverse proximity effect, Cooper pairs-magnons interactions or injection of polarized quasiparticles at superconductor/ferromagnet (S/F) interfaces have been essentially investigated in niobium or aluminium-based heterostructures grown by sputtering [1,2] with critical temperatures (Tc) of the order of few Kelvin. S/F stacks with a higher Tc and carefully tuned interfaces would enable the thorough exploration of new superconducting spintronic features, as well as the possible implementation in operating quantum devices.

We will present the growth of epitaxial MgB_2-based and NbN-based stacks (see TEM image in Fig. 1(a)). Tc reaches 30K for MgB_2 films thicker than 15nm and is above 2K for MgB_2 films as thin as 5 nm (Fig. 1(b)). The original magnetic properties of such thin films will first be discussed and explained [3]. Besides, the growth of a Co or Permalloy layer on top of MgB_2 only reduces Tc by about 1K and allows us to investigate MgB_2/F stacks having Tc above or close to 30K. The temperature dependent magnetization damping of the F layer is extracted from FMR measurements, in order to probe spin-transport from F into MgB_2. As expected from previous works on Nb/$Ni_{80}Fe_{20}$ [1] and NbN/$Ni_{80}Fe_{20}$ [2], the channel of momentum loss in the MgB_2 layer is suppressed by opening of the superconducting gap below Tc. It results in the drop of the damping parameter below Tc in MgB_2/$Ni_{80}Fe_{20}$ (Fig.1(c)) and MgB_2/Co bilayers [4]. The role of the interface transparency will be further discussed based on comparable FMR measurements on NbN/X/F-based stacks where X being either Pt or Cu. Our results on epitaxial MgB_2-based thin films and heterostructures allows the investigation of superconducting spintronic physics over a large range of temperature and under temperatures larger than the H_2 liquid-gaz transition.

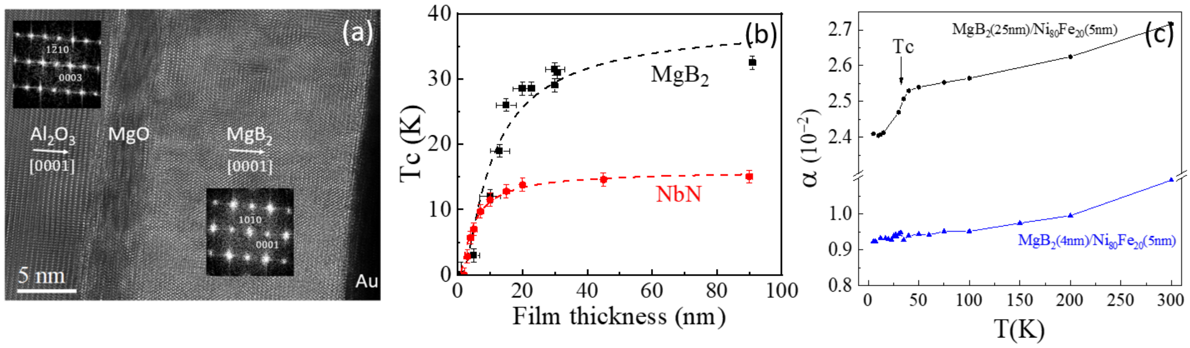

Figure 1. a) High resolution TEM micrograph of a Al2O3/MgO/MgB2/Au structure. b) Critical temperature of single crystalline MgB_2 (black) and NbN (red) thin films measured for various thicknesses. c) Variation of Gilbert damping for two MgB_2/$Ni_{80}Fe_{20}$ stacks, with (black dots) and without (blue triangles) superconducting transition.

References

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