

Spin injection at MgB₂-superconductor/ferromagnet interface

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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 (T_c) of the order of few Kelvin. S/F stacks with a higher T_c 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 report here the growth of epitaxial MgB₂/F-based and NbN/F-based stacks (see TEM image in Fig. 1(a)). T_c reaches 30K for MgB₂ films thicker than 15nm and is above 2K for MgB₂ films as thin as 5 nm (Fig. 1(b)). The growth of a Co or Permalloy layer on top of MgB₂ only reduces T_c by about 1K and allows us to investigate MgB₂/F stacks having T_c 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 MgB₂. As expected from previous works on Nb/Ni₈₀Fe₂₀ [1] and NbN/Ni₈₀Fe₂₀ [2], the channel of momentum loss in the MgB₂ layer is suppressed by opening of the superconducting gap below T_c . It results in the drop of the damping parameter below T_c in MgB₂/Ni₈₀Fe₂₀ (Fig.1(c)) and MgB₂/Co bilayers. The role of the interface transparency can be further discussed based on comparable FMR measurements on NbN/F-based stacks. Our results on epitaxial MgB₂-based thin films and heterostructures allows the investigation of superconducting spintronic physics over a large range of temperature and under temperatures larger than the H₂ liquid-gaz transition [3,4].

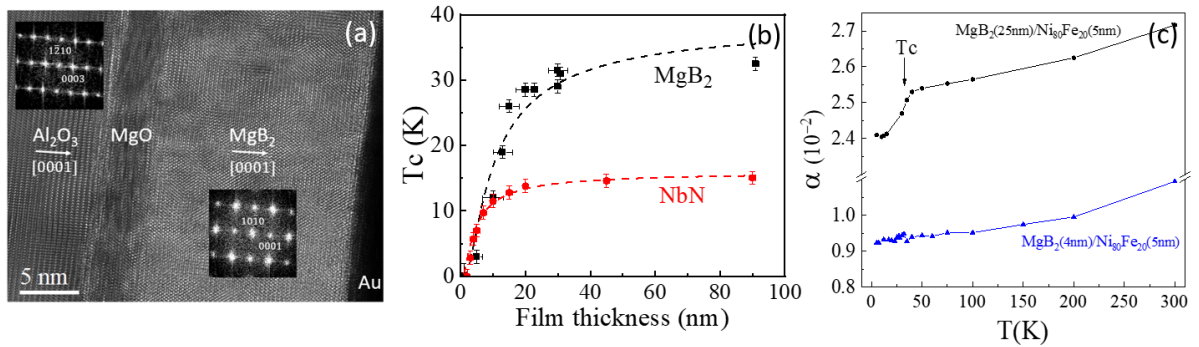


Figure 1. a) High resolution TEM micrograph of a Al₂O₃/MgO/MgB₂/Au structure. b) Critical temperature of single crystalline MgB₂ (black) and NbN (red) thin films measured for various thicknesses. c) Variation of Gilbert damping for two MgB₂/Ni₈₀Fe₂₀ stacks, with (black dots) and without (blue triangles) superconducting transition.

References

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