The role of MBE epitaxial grown Fe/Pt bilayers in optimizing the spin-pumping induced inverse spin Hall voltage and the THz emission

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The generation of a spin current via the spin-pumping effect (SP) and its detection through the inverse spin Hall effect (ISHE) is a key topic of research in the spintronics community [1]. A spin current is generated at the interface between a ferromagnetic material (FM) or a ferrimagnetic insulator (for example, YIG) and a nonmagnetic metal (NM) by a precessing magnetization in the magnetic layer. Recently, the decisive role of the ISHE effect on extending the field of spintronics in the terahertz regime was revealed [2,3].

The efficiency of spin-pumping depends on the transparency of the interface quantified by the parameter termed spin mixing conductance [1]. Here, we structurally modify the interface transparency by using molecular beam epitaxy method (MBE) in Fe/Pt based heterostructures [4,5]. We furthermore introduce a tunnelling MgO barrier at the FM/NM interface in order to probe the ISHE [6].

Fe/Pt and Fe/MgO/Pt samples series were prepared with the MBE method with Fe and Pt thicknesses ranging from 0.5 nm to 12 nm and MgO thicknesses from 0.5 to 2 nm. We show that by optimizing the degree of interfacial epitaxy between Fe and Pt large spin Hall angles can be obtained in Pt together with efficient generation of broadband terahertz radiation.

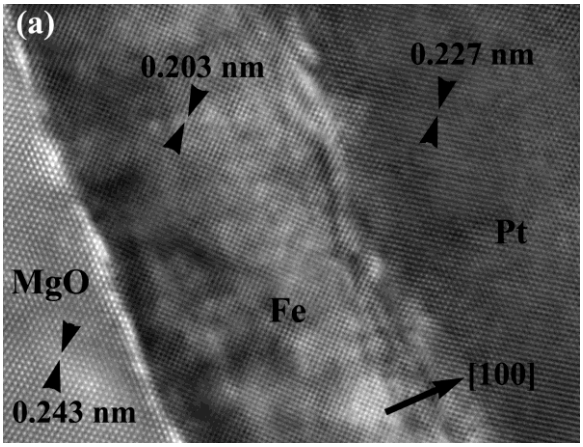

Fig. 1: High resolution transmission electron microscopy image from an epitaxial grown Fe/Pt bilayer. The {111} MgO, {011}Fe, and {111}Pt lattice fringes are clearly resolved, along the [011]MgO-Pt//[001] Fe projection direction [4].

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