Supplementary Material: Experimental Evidence of the Topological Surface States in Mg_3Bi_2 Films Grown by Molecular Beam Epitaxy

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METHODS

Sample preparation

The Mg_3Bi_2 films were grown on 2×10 mm 6H-SiC(0001) substrate with epitaxially grown Graphene by MBE. The base pressure was maintained at 3×10^{-11} mbar and the vacuum was better than 2×10^{-10} mbar during growth. Mg (3N) and Bi (5N) sources were thermally evaporated from standard Knudsen cells. Mg and Bi were kept at 380°C and 540°C and with the flux rate of 0.661Å/s and 0.112Å/s (measured by Quartz crystal micro-balance), respectively. The flux ratio between Mg and Bi should be at least ~5:1 to minimize Mg vacancies and ensure the high quality of the as-grown films. The substrate was kept at 350°C during the growth and the quality of the film was monitored by *in-situ* RHEED.

Measurements

For the ARPES measurements, the spectra are excited by the He Iα (21.2 eV) resonance line of a commercial Helium gas discharge lamp. The light is guided to the analysis chamber by a quartz capillary. In virtue of the efficient three-stage differential pumping system, the pressure in the analysis chamber is better than 2.0×10^{-10} mbar during our experiments. A VG Scienta DA30L energy analyzer is used to collect the photoelectrons. Mg_3Bi_2 film with the thickness of 50nm was transferred *in-situ* into the ARPES chamber and measurements were done at 12K. The magneto-transport measurements were performed with the standard four-probe technique using silver paint as contacts by Physical Property Measurement System (PPMS-9). The samples for transport measurements is about 50 nm thick in a rectangular shape (5 mm × 6 mm) grown on Al_2O_3(0001) substrate.

The detailed fitting procedure on SRB slope

Considering the symmetry of SRB1 and SRB2 around $\bar{\Gamma}$, we fit the band by the equation of $y=a\times|x|+b$, where |x| represent the absolute value of x. From Figure S1 we can see that the SRB band between -0.08~-0.22eV of the energy fits well by $y=-4.908\times|x|+0.191$, and we thus conclude that the slope of SRB band is C=±4.91.

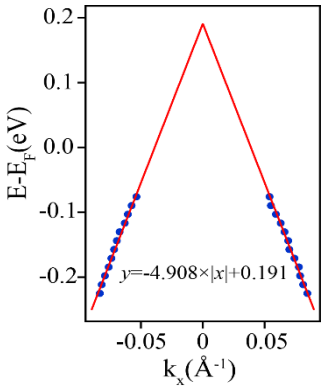

Figure S1. **The fitting method for SRB slope.** The blue circles indicate SRB band extracting from the MDC peaks and the red line depict the fitting results.

Characterization of Mg_3Bi_2 on Al_2O_3

For magneto-transport measurements, we grew Mg_3Bi_2 films on Al_2O_3(0001) substrate by MBE to exclude the substrate conducting effects. The characterization of Mg_3Bi_2 on Al_2O_3 is shown in Figure S2. The in-plane lattice constant of Al_2O_3 is 4.758 Å while that of Mg_3Bi_2 is 4.677 Å, which means there is very little mismatch to grow Mg_3Bi_2 on Al_2O_3. The sharp RHEED streaks prove that and show high quality of Mg_3Bi_2 film (Figure S2 (a) and (b)). XRD patterns represents the (001), (002), (003), (004) and (005) peaks of Mg_3Bi_2, which indicates that the films grow along the *c*-axis on Al_2O_3 (Figure S2 (c)).

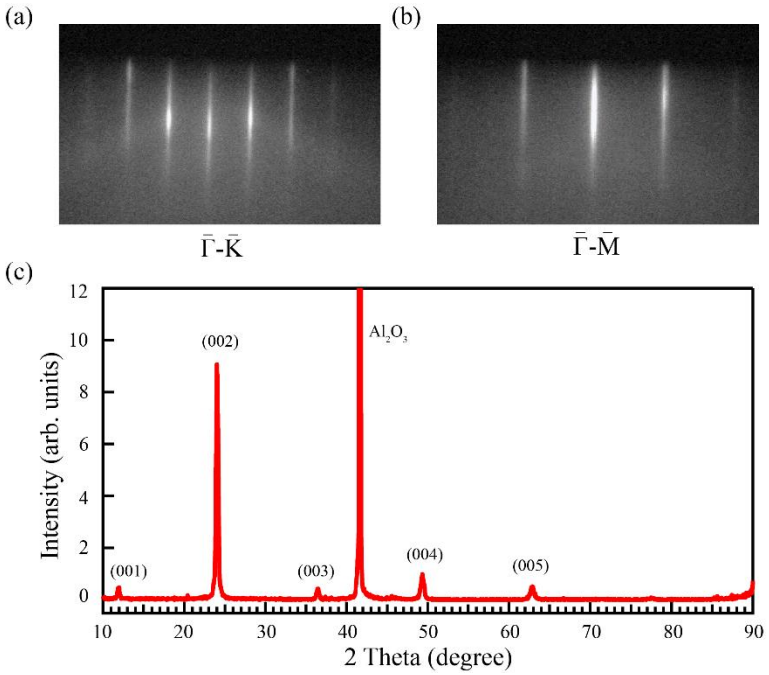

Figure S2. **Characterization of Mg_3Bi_2 film on Al_2O_3. (a)** and **(b)** The RHEED patterns of Mg_3Bi_2 film grown on Al_2O_3(0001) substrate, with the incident electron beam along the $\bar{\Gamma}$–$\bar{K}$ and $\bar{\Gamma}$–$\bar{M}$ directions, respectively. **(c)** The XRD spectra of Mg_3Bi_2 on Al_2O_3. The sharp RHEED streaks and XRD spectra are indications of high quality of Mg_3Bi_2 film on Al_2O_3.