APPLICATION NOTE

Large Rashba effect observed with Scienta ARTOF 10k

The field of spintronics deals with ideal devices which can operate using the electron's spin, rather than its charge. A new class of materials, called topological insulators, is intensively studied in the past years. Their unusual property is that the surface behaves as a metal, whereas its bulk structure has a semiconductor behavior.

The recent ARPES results (P. D. C. King et al., published in Phys. Rev. Lett. 107, 096802 (2011) show the large Rashba spin-splitting of a two dimensional electron gas using ARPES and a Scienta ARTOF 10k spectrometer. The prototype topological insulator, Bismuth Selenide, shows a 10 times higher spin-splitting than other semiconductors, such as silicon or gallium arsenide. This very large Rashba effect would allow the production of spin transistors on the nanometre scale.

The data were recorded at 10 K sample temperature, with vacuum in the 10^{-9} mbar range. The photon energy set at the U125/10m-NIM beamline at the BESSY II synchrotron radiation facility was 19.2 eV. The experimental setup (iDEEAA) consists of a Scienta UHV double-mu metal chamber with a VG Scienta R4000 hemispherical spectrometer (not used in this work) and an ARTOF 10k time-of-flight spectrometer, arranged orthogonally.

The complete 3D band structure of the Bi_2Se_3 model topological insulator is revealed in one measurement within the full ±15° acceptance cone of the Scienta ARTOF 10k. The spectrometer was set in fixed mode using a 10% energy window around 14.5 eV central kinetic energy. The splitting appears about 30 minutes after cleaving the sample during data acquisition at 1.25 MHz repetition rate of the BESSY II electron storage ring. The combined beamline and spectrometer energy resolution was about 3.9 meV (FWHM). The angular resolution was better than 0.2° (FWHM) along both
k_x and k_y directions (Working with best angular resolution was not a goal of this experiment).

These results show a promising step towards nanoscale miniaturization of spintronic devices and their performance at room temperature.

Data courtesy: C. Lupulescu (TU Berlin), R. Ovsyannikov (HZB)

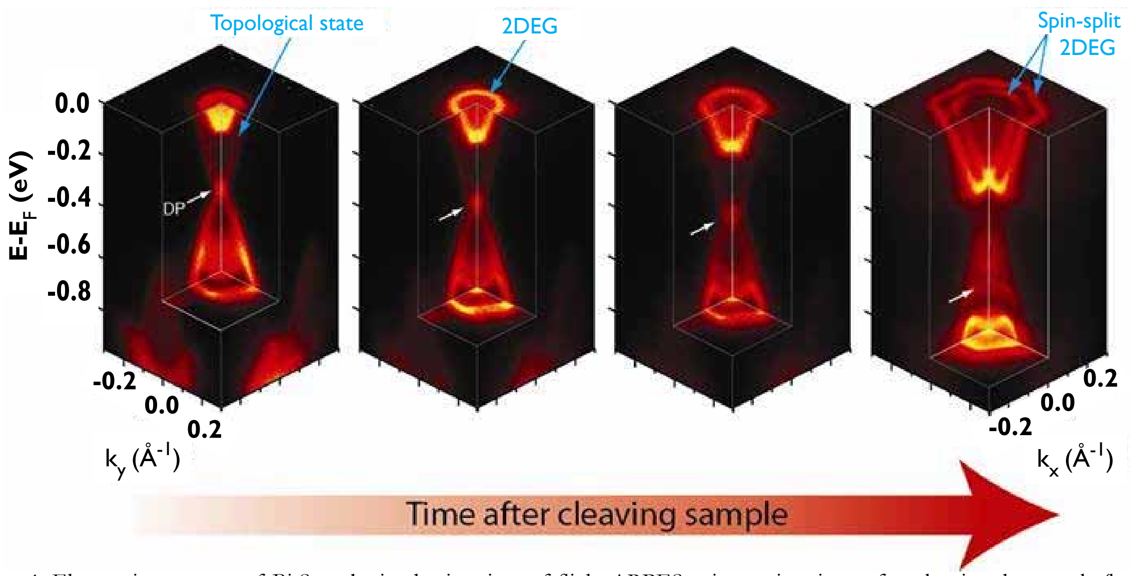

Figure 1: Electronic structure of Bi_2Se_3, obtained using time-of-flight ARPES at increasing times after cleaving the sample (hν= 19.2 eV).

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