Ballistic electron emission microscopy (BEEM) studies using ANP100 nanopositioners

Electrical injection, transport, manipulation and detection of spin polarized electrons in a semiconductor are essential requirements for utilizing the spin degree of freedom in a future semiconductor spintronics technology. One suitable instrumental technique hereby is the ballistic electron emission microscopy (BEEM) which allows simultaneous measurements of the tunneling current and a resulting ballistic current entering the semiconductor.

A research team from the Department of Physics at the University of Regensburg in Germany is using the tip of a scanning tunneling microscope as an injector of hot electrons or holes into spin valves as well as into cleaved edge overgrown heterostructures. Recently, they have studied the spin-dependent transport of injected and hole excited electrons through epitaxial spin valves in an external magnetic field at room temperature (1).

Figure 1 shows such a STM/BEEM instrumental setup where the atto**cube** ANPxyz100 nanopositioners are implemented enabling the coarse positioning of the sample. This positioning stack offers a travel range of 7 x 7 x 6 mm by having a size of 24 x 24 x 53 mm and is also applied to establish the tunneling contact between the STM tip and the sample. The scanning process itself is performed by a dedicated tube scanner. Figures 2 and Figures 3 describe previous results when scanning across a GaAs/AlGaAs heterostructure, which has been cleaved and overgrown with an iron and gold layer. For instance, when applying high tunneling voltages of 2.5 V the various GaAs and AlGaAs sections can be clearly seen due to differences of approx. 300 meV in the Schottky barrier heights (Figure 2). These differences result in variations of 800 fA in the collector current. Figure 3 clearly exhibits the differently obtained image types.

The ANPxyz100 stepper positioners

These results are another demonstration of the reliable performance and stability of atto**cube**'s ANPxyz100 nanopositioner stack for STM and STM-like applications.

Reference:

(1) E. Heindl et al., "Ballistic electron magnetic microscopy on epitaxial spin valves", Phys. Rev. B, **75**, 073307 (2007).

The data was generously provided by E. Heindl from the Department of Physics, University of Regensburg, Germany.

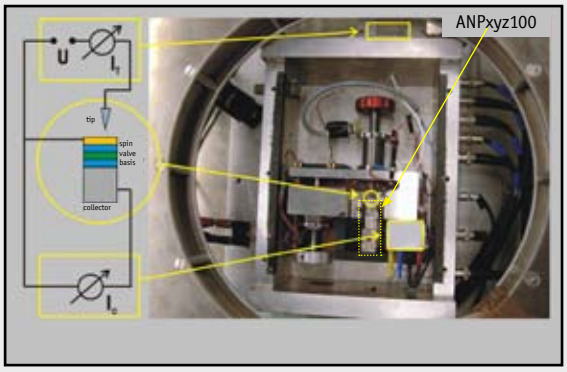

Fig. 1: Photo of the BEEM setup.

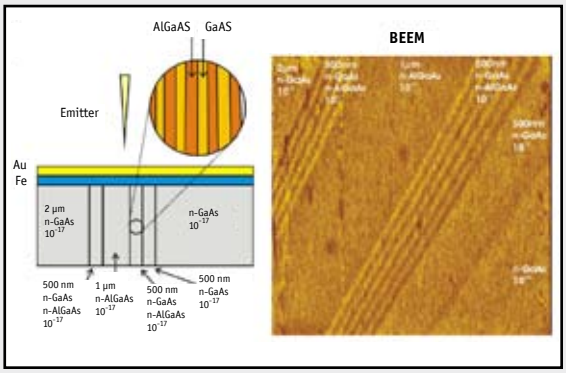

Fig. 2: Au/Fe on a GaAs/AlGaAs heterostructure
a) schematic cross section of the sample,
b) BEEM measurement with I_T = 25 nA, E = 2.5 V ,
(2 x 2 µm scan).

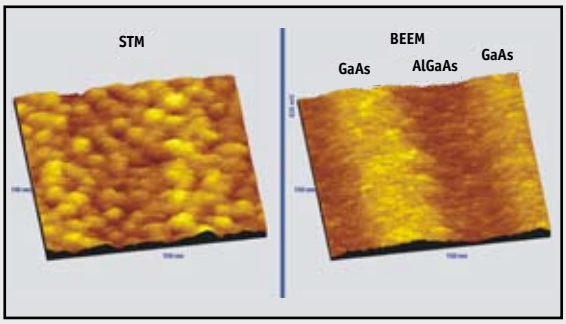

Fig. 3: Comparison of image contrast for STM (topographical effects) and BEEM measurements (different Schottky barrier heights) when performing a 150 x 150 nm scan.

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