Interface Energy Barrier Inhomogeneity of Pt/4H-SiC Junction Probed with Planar Ballistic Electron Emission Spectroscopy

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The inhomogeneity of the interfacial energy barrier is associated with crystallographic variations of the interface, which is inevitable in heterojunctions. The ballistic electron emission microscopy/spectroscopy (BEEM/BEES) has been commonly used to observe the local variation of interfacial energy barrier with high spatial resolution (1-10 nm) [1]. However, the tip-related issues [2, 3] and long scanning time make it difficult to investigate the large area reliably. Here, we suggest an experimental methodology utilizing the device version of BEES to estimate the inhomogeneity of interfacial energy barrier with single spectral measurements covering the entire junction area. Our approach (*i*) relies on the Bell-Kaiser theory [1] for a 'point' BEEM response, (*ii*) treats the tunnel junction as an ensemble of virtual BEEM tips, and (*iii*) models the second-derivative spectrum (SDS) of the 'lumped' BEEM response using a known statistical nature of interfacial barriers [4]. For the case of simple two distinct Schottky barriers (SBs), the working principle of 'planar BEES' is illustrated in Fig. 1. To validate our methodology, we apply it to Pt/4H-SiC junction, adopting the Gaussian distribution of interfacial barriers. In its SDS (see Fig. 2), we observe two peaks at 1.60 V and 1.74 V corresponding to two lowest conduction band minima of 4H-SiC located at the M point of the Brillouin zone [5] and the standard deviation of SB is obtained to be 156.7 meV. Our methodology can be used broadly for other heterojunctions as long as the inhomogeneous interface possesses the Gaussian nature.

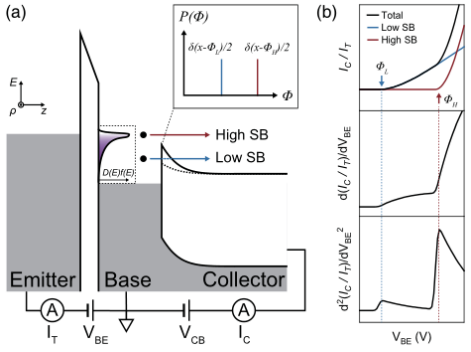

Figure 1 Working principle of Planar BEES

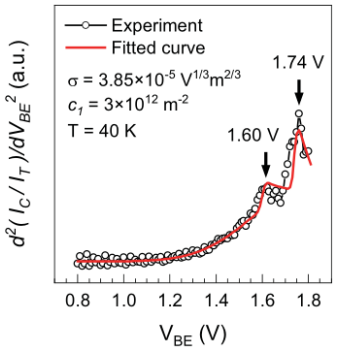

Figure 2 SDS of Pt/4H-SiC(0001)

[1] L. D. Bell and W. J. Kaiser, Phys. Rev. Lett. **61**, 2368 (1988).
[2] M. Prietsch and R. Ludeke, Phys. Rev. Lett. **66**, 2511 (1991).
[3] J. P. Pelz and R. H. Koch, Phys. Rev. B **41**, 1212 (1990).
[4] R. T. Tung, Phys. Rev. B **45**, 13509 (1992).
[5] B. Kaczer, H.-J. Im, J. P. Pelz, J. Chen, and W. J. Choyke, Phys. Rev. B **57**, 4027 (1998).

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