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Probing semiconductor band structures and heterojunction interface properties with ballistic carrier emission: GaAs/AlxGa1-xAs as a model system WEI YI, VENKATESH NARAYANAMURTI, School of Engineering and Applied Sciences, Harvard University, Cambridge, Massachusetts 02138, USA, HONG LU, MICHAEL A. SCARPULLA, ARTHUR C. GOSSARD, Materials Department, University of California, Santa Barbara, California 93106, USA, HARVARD TEAM, UCSB TEAM — Utilizing tunnel emission of ballistic electrons and holes in a tunnel transistor with a Mott-barrier collector, we have developed a method to self-consistently determine the energy gap of a semiconductor and band offsets at a semiconductor heterojunction without using a priori material parameters. As a model system, electronic band gaps of the AlGaAs alloys together with conduction and valence band offsets at the GaAs/AlGaAs (100) interfaces are measured with a resolution of several meV at 4.2 K. The direct-gap band offset ratio for the GaAs/AlGaAs (100) interface is found to be 59:41. In the indirect-gap regime, ballistic electrons from direct tunnel emissions probe the X valley in the conduction band, while those from Auger-like scattering processes in the metal base film probe the higher-lying L valley. Such selective electron collection may be explained by their different momentum distributions and parallel momentum conservation at the quasiepitaxial Al/GaAs (100) interface. We argue that the present method is in principle applicable to arbitrary type-I semiconductor heterostructures. [W. Yi. at al. Phys. Rev. B 81, 235325 (2010)]

Wei Yi
School of Engineering and Applied Sciences,
Harvard University, Cambridge, Massachusetts 02138, USA

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