Abstracts

Barrier enhancement mechanisms in heterodimensional contacts and their effect on current transport

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It has been shown that, in a three-dimensional (3D) to two-dimensional (2D) contact system, the quantized nature of the energy of the 2D system imposes important changes on thermionic emission of carriers from a 3D metal to two-dimensional electron gas (2DEG). Interestingly, in actual devices, barrier heights higher than what is theorized based on the first confined state are measured. In this paper, we introduce an additional mechanism that explains barrier height enhancement in 3D-2D contacts, which is due to the repulsive Coulombic force that is exerted by the 2DEG on the thermionically emitted electrons. An analytical derivation of the barrier height due to this effect is given and total thermionic emission current is derived. These results are particularly important for design and understanding of device behavior for low-noise photodetectors in front end optical receivers. The electron cloud model presented for the reservoir of mobile charges that are free to move in response to charged particle or electromagnetic waves implies that any means of interaction that disturbs the equilibrium of the electron cloud have strong signature at the contact, as well as the temporal response of the induced disturbance. This can be effective for low-power-detection applications.

❑ Return to main document.