Comment on "Observation of Intrinsic Bistability in Resonant-Tunneling Structures"

I am compelled to write because the current-voltage (I-V) curve presented by Goldman, Tsui, and Cunningham[1] as their sole evidence of bistability has been seen in our laboratory many times, and it occurred not because of charging of the well, as is claimed, but because of oscillations in the negative-resistance region. Indeed, hysteresis is evident in Fig. 1(a) of Goldman, Tsui, and Cunningham in which oscillations are acknowledged. The authors argue that the placement of a capacitor across the terminals removed the possibility of oscillation. However, a capacitor, since it is purely reactive, will not always suppress oscillations. The output power available from this resonant-tunneling structure during oscillation is at most[2] 10 μW, so that it would be easy to miss oscillations if they were present, especially if a capacitor across the terminals reduced the amplitude even further.

Figure 1 shows a typical I-V curve of one of our resonant-tunneling diodes which is oscillating (as measured with a spectrum analyzer). The similarity of Fig. 1 to the I-V curve in Fig. 1(a) or 1(b) of Goldman, Isui, and Cunningham is striking. The reason for the hysteresis in the present case is the simple fact that it is necessary to bias the diode nearer the region of maximum negative conductance to begin oscillations (the innermost discontinuities indicated by arrows) than to suppress oscillations after they have begun (the outermost arrows). For the device of Fig. 1 it was very difficult to quench the oscillations since the negative impedance is only approximately 100 Ω. Any series inductance, say from bond wires, often makes it impossible to measure stable negative resistances less than 1000 Ω.

The negative impedance of the device described by Goldman, Tsui, and Cunningham is also approximately 100 Ω, and so there is an excellent chance that it is oscillating in spite of the precautions taken. Thus while the effect of hysteresis due to well charging should exist, and has been predicted theoretically,[3,4] the authors have not yet demonstrated that they have observed it.

There is an easy way for the authors to prove that their structures do show the desired effect. Devices of the same material, but of much smaller diameter, can be fabricated and tested. It is a simple matter to stabilize devices with impedances of several kilohms against oscillations, but the well-charging effects should remain the same.

There appears to be sufficient doubt about the oscillation condition of the original experiments by Goldman, Tsui, and Cunningham that their interpretation should not be taken seriously until the simple experiment suggested above has been completed and reported by the authors.

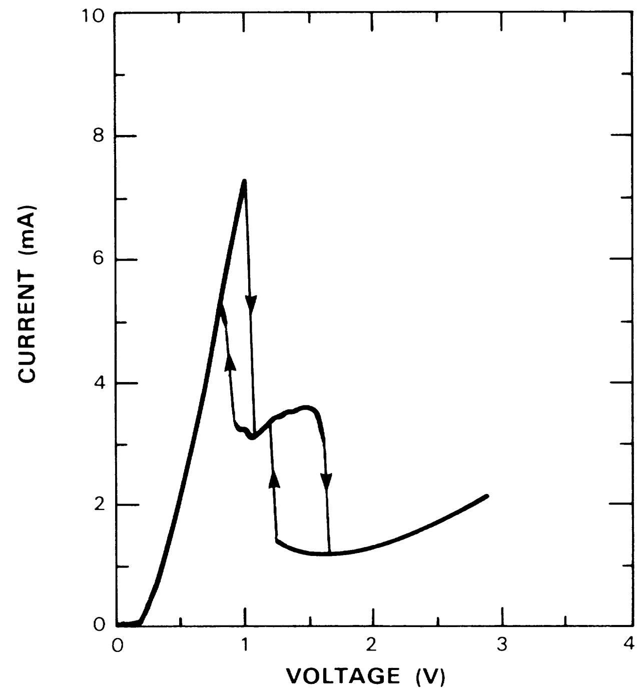

FIG. 1. Current-voltage (I-V) curve of a double-barrier resonant-tunneling structure taken when the device was known to be oscillating. The hysteresis occurs because of the oscillations. Goldman, Tsui, and Cunningham (Ref. 1) show a very similar I-V curve, but claim that the hysteresis is due to charging of the well.

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