Resonant Tunneling from Inception to Applications

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BIOGRAPHY

Professor Raphael Tsu (with Tsu replaced by Zhu in pinyin) is a world leader in the areas of quantum properties of materials and device physics. An acknowledged authority in these subjects Professor Tsu has published nearly two hundred scholarly papers in scientific journals; an author of a monograph on quantum wells and superlattice materials and devices [1] of which he is a co-inventor, holder of several patents for his discoveries and invention. The description of his research contributions while at the IBM, T.J. Watson Research Center in Yorktown Heights was presented to the White House by the US Army Research Office, The Superlattice Story, played an important role in the 90’s towards the US National Nanoscience Initiative (NNI).

TECHNICAL ABSTRACT

After a brief review why resonant tunneling was introduced during the pursuit of man-made superlattices, several key systems utilizing resonant tunneling serve to illustrate the inter-relationship among these applications, for example, as matching section to allow the transfer of excitations, as well as selectively couple the input/output. The unique difference between tunneling through quantum wells and quantum dots will be discussed.

In particular, the discovery in theory of the role of symmetry in the capacitance of quantum dots with few electrons should be explored in an experimental setup, dealing with the roll of symmetry in resonant tunneling. In particular, high power devices and lasers are dominated by vertical systems, whereas ICs with MOSFETs are primarily monolithic, meaning everything happens on a plane. Interestingly, Bell Labs, where transistors were first demonstrated, did not pursue ICs while Texas instrument did. Nicollian, told me how MOSFET after invention by Dawon Kahng and was downgraded allowing other places to pursue it. Almost all electronic systems are manufactured with lithography. For resonant tunneling to take part in current device developments, accept as THz oscillators, it is important to devise means to incorporate the principle of resonant tunneling compatible with current monolithic design. After all, the first Nobel Prize awarded to quantized conductance in solids involved a MOSFET-like structure. Recently band-edge alignments leading to Type III superlattices introduced almost 40 years ago are hot topics. Nevertheless, carrier transfer via interface effects leading to quantization may be a thing to dominate for the next few decades.

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