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"Heterostructures for Everything: Device Principles of the 1980's?"

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It has now been ten years since the experimental realization, by LPE, of the double heterostructure laser. The first such lasers are used in actual communications systems. Many other heterostructure devices are in development, and new technologies, especially MOCVD and MBE offer particular promise for heterostructures. I believe that, as a result of these developments, one of the dominant themes of semiconductor device development during the 1980's will be the incorporation of heterostructures into most existing classes of devices, and the emergence of new kinds of devices made possible by heterostructures.

The possible improvements in existing devices are particularly pronounced in bipolar devices. Attempts to place wide-gap emitters upon Si base/collector structures should lead to greatly improved Si bipolar transistors, but the longer-term development is more likely to utilize all-III/V structures in which both emitter and collector have a wider energy gap than the base. The idea is to use gap variations in addition to doping and bias to control carrier flow. The current dominance of the III/V transistor field by FET's is likely to come to an end, with bipolar devices assuming an equal role, particularly in high-speed VLSI circuits. The talk will discuss some of the structural possibilities offered by a free use of energy gap variations as a design parameter.

Many devices of the future will draw extensively on quantum well structures made possible by heterostructures with layer thicknesses of the order 100 Å and below. The exact role of quantum well structures is more difficult to predict than that of non-quantum bipolar heterostructures. Quantum well structures seem to be particularly suited for use in entirely new classes of devices rather than to improve existing kinds. New problems in basic solid state physics arise when the depth of narrow quantum wells reaches an appreciable fraction of the energy gap of the semiconductor inside the well: The effective mass approximation then breaks down, and this leads to new kinds of physical properties. They are only beginning to be studied, but they can be predicted to be an extensive area of research during the 1980's. One of the most likely results is the emergence of unusual electron transport properties along the quantum wells, but there will probably be others. The talk will close with some speculations about the direction this kind of research might take during the 1980's.