Introduction to RTDs: Realistic Doping Profiles

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RTD Conduction band profile with realistic doping profile

- Need extremely high doping for high current densities
- Impurity scattering can destroy the RTD performance

=> undoped spacer 20-100nm

- Electrons diffuse from high density contacts to low density RTD
- Potential floats up to repel the electrons

- Overall RTD is raised above the Fermi levels
0 and 0.32V bias

Under Bias:

- triangular quantum well in emitter.
- charge build-up against the RTD in emitter
- charge depletion on the collector side.
- charge shows a strong spike which cannot occur in reality due to the wave-nature of the carriers.
Interaction the triangular well states and the central RTD
Current-Voltage characteristic

- Multiple peaks are visible.
- Central resonance probes the states in the emitter
Current-Voltage characteristic and trace of resonance energies

- Multiple peaks are visible.
- Central resonance probes the states in the emitter.
Bias Dependence of Resonance Widths

- Width of C1 ~0.4meV weak bias dependence
- Width of E1 varies exponentially with bias! Can become VERY narrow Truly bound state!
• Realistic RTDs have a non-uniform doping profile that keeps dopants away from the central RTD to avoid ionized impurity scattering

• The non-uniform doping profile results in a non-uniform electrostatic potential profile above the Fermi levels in the high contact regions

• An applied bias causes a potential drop not only in the central RTD region but also in parts of the emitter. That potential drop in the emitter creates a triangular potential well.

• The tri-angular potential well in the emitter binds quantum mechanical states which can interact with the central RTD states.

• The quasi-bound emitter states resonance widths vary exponentially with the applied bias and can become extremely narrow.