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# A Comparative Study of Fixing One Barrier-Varying Another Barrier for a Resonant Tunneling Diode

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***Abstract*— In this research paper, the effects of fixing one barrier and varying another barrier have been analyzed and compared for a GaAs/Al0.3Ga0.7As based double barrier resonant tunneling diode for two different models - Hartree Quantum Charge model and semi-classical Thomas Fermi model. VI characteristic graphs are studied to assess the overall performance of both models. The simulations are carried out in a nanoelectronics modeling tool suite – Nano electronic Modelling 5 (NEMO5) considering Non-Equilibrium Green's Function (NEGF), at room temperature of 300K and biased voltage of 0 to 0.5 V. In this paper, it was demonstrated that a very larger amount of current is supplied by both models when the first barrier is varied and second barrier is fixed in comparison to the first barrier when kept fixed and second barrier is varied. But as quantum charge inside the quantum well is existed in the Hartree model, so overall Hartree model supplied a greater amount of current compared to the Thomas Fermi model. Quantum charge inside its quantum well is not present in the Thomas Fermi model. But a better NDR region is created by the Thomas Fermi model in both varied first barrier-fixed second barrier and fixed first barrier-varied second barrier cases compared to the Hartree model. This NDR region can be used for numerous digital applications. On the other hand, a vast range of analog applications can be used by the Hartree model that produced larger current per unit voltage.**

***Index Terms*— Resonant Tunneling Diode (RTD), Double Barrier Resonant Tunneling Diode (DBRTD), Fixed Barrier, Varied Barrier, First Positive Differential Resistance (PDR1), Negative Differential Resistance (NDR), Second Positive Differential Resistance (PDR2), Non-Equilibrium Green's Function (NEGF).**

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## I. Introduction

To represent RTD, and three equivalent proposals are worked out which include the non-equilibrium green function (NEGF) scheme, the Schrodinger equation method, and the Winger equation [1]. All the states are found with the support of open boundary conditions. At the Hartree level, the interaction of electrostatic force is taken into account. In a less particular way with Thomas-fermi approximation, the coherent property is promoted [2].

A very strongly creative and calculated model is provided by non-equilibrium green function formalism by the use of quantum transport in high-tech [3]. To add the inflexible scattering and powerful effects of correlation at an atomistic level [3], it excels in the Landauer proposition for choleric, non-interacting electrons.

The interest of using RTDs in different analog and digital applications risen gigantically after the initiating contributions of Chang, Esaki and Tsu [4]. The first presentation about the resonant tunneling structure was begun by these three researchers in 1974 [4]. They displayed RTDs as a substitute for transistors for high-frequency oscillations for use in microwave circuits and even for logic circuits. RTDs possess the widest bandwidth recently among all the semiconductor devices.

## II. Theory and Methodology

### A. Layers of DBRTD

There are seven different layers in a GaAs/Al0.3Ga0.7As double barrier RTD. By rising current density in RTD, contact 1 and contact 2 aid large electron count. They are also known as Lead 1 and Lead 2. By the phenomenon of highly doped contacts, spacer 1 and spacer 2 impede the diffusion of impurity atoms' scattering through two barriers and a well. In the conduction band, barrier 1 and barrier 2 operate as potential blockades for electrons. Well emerges quasi-bound states that cause resonant transmission.