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Non-Equilibrium Green's Function Calculation for Electron Transport through Magnetic Tunnel Junction

Sara Nobakht, Adeleh Vatan-Khahan and Hadi Arabshahi
Physics Department, Khayyam Higher Education Institute, Mashhad, Iran

Abstract
In this paper non-equilibrium Green's function method –dependent electron transport through non magnetic layer (insulator) has been studied in one dimension .electron transport in multi-layer (magnetic/non magnetic/ magnetic)layers is studied as quantum .the result show increasing the binding strength of the electrical insulator transition probability density case , the electron density , broad levels of disruption increases. Broad band connection increases the levels of disruption to electrical insulation and show non- conductive insulating state to semiconductor stat and even conductor

I. Introduction

Tunnel magneto resistance (TMR) is a magneto resistive effect that occurs in a magnetic tunnel junction (MTJ), which is a component consisting of two ferromagnets separated by a thin insulator. If the insulating layer is thin enough (typically a few nanometers), electrons can tunnel from one ferromagnet into the other. Since this process is forbidden in classical physics, the tunnel magneto resistance is a strictly quantum mechanical phenomenon .The main feature of this system, Tunneling current depends on the relative orientation of the magnetization of the two ferromagnetic layers.The direction of the two magnetizations of the ferromagnetic films can be switched individually by an external magnetic field. If the magnetizations are in a parallel orientation it is more likely that electrons will tunnel through the insulating film than if they are in the oppositional (anti parallel) orientation. Consequently, such a junction can be switched between two states of electrical resistance, one with low and one with very high resistance. In this paper, electron transport in multi-layer(magnetic/non magnetic/ magnetic)layers is studied as quantum .All the curves in this paper are plotted by using MATLAB programming .This paper is organized as follows . Details of non equilibrium Green's function the model in section 2 and the results of the transition probability density of states ,a board concentration levels and the power connector insulated electrodes were calculated in section 3.

II. Model details

Non equilibrium Green's function (NEGF) technique plays the central role in the development of generalized approaches to the study of transport in nanostructures. This approach systematically takes into account the band structure, electron correlation effects, non equilibrium occupations, layer thickness, applied bias and temperature in the calculation of the current and hence it can provide a reliable description of the transport in these systems. Our present interest is on the transport in magnetic tunnel junctions (MTJs) and we have employed the NEGF techniques to study the magneto transport in MTJs [1]. The solution of single-particle quantum problems, formulated with the help of a matrix Hamiltonian, is possible along the usual line of finding the wave functions on a lattice, solving the Schrödinger equation [2]. The other method, namely matrix Green functions, considered in this section, was found to be more convenient for transport calculations, especially when interactions are included. The retarded single-particle matrix Green function $G^R(\varepsilon)$ is determined by the equation

$$[(\epsilon + i\eta)I - H]G^R = I \qquad 1$$

Where η is an infinitesimally small positive number $\eta = 0^+$.

For an isolated non interacting system the Green function is simply obtained after the matrix inversion [3].

$$G^R = [(\epsilon + i\eta)I - H]^{-1} \qquad 2$$

In the next section, we'll study it with an example.

III. Results

In this section, we studied an analytical example of the transport. figure 1 is considered for two connect . This is the Hamiltonian.

$$[H] = E_c + 2t_0 + (\frac{u_0}{a}) \qquad 3$$

We show effects caused connect with adjacent layers in the self-energy sentences as face following.

$$\sum_1 (E) = -t_0 \exp(ika) \quad 4$$

$$\sum_2 (E) = -t_0 \exp(ika) \quad 5$$

So Green's function is:

$$G = [EI - H - \Sigma_1 - \Sigma_2]^{-1} = [E - E_c - 2t_0 \exp(ika) - \frac{u_0}{a}]^{-1} \quad 6$$

And transport's function is :

$$T(E) = Trace[\Gamma_1 G \Gamma_2 G^{+}] = \left(\frac{(2at_0 \sin(ka))^2}{(2at_0 \sin(ka))^2 + u_0^2}\right) \quad 7$$

In problem, a =0.3 (nm), u_0=0.4 (ev) and (effective mass) m=0.025 m_0 .The figures 2 and 3 show energy in the equilibrium state and energy in terms of transport's function. In figure 3 shows two sharp peaks and difference between the two peaks is due to the potential barrier between the two layers.

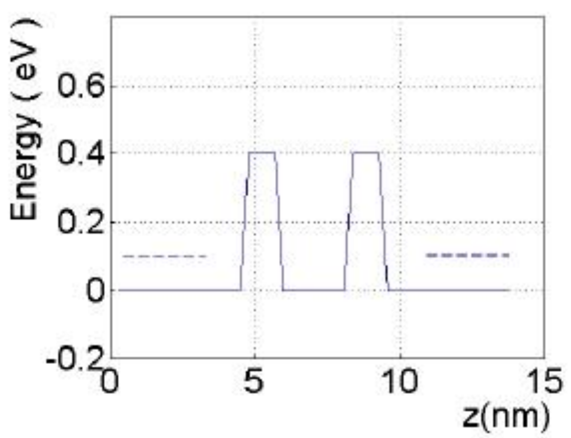

Fig 2. Changes energy in terms of Location

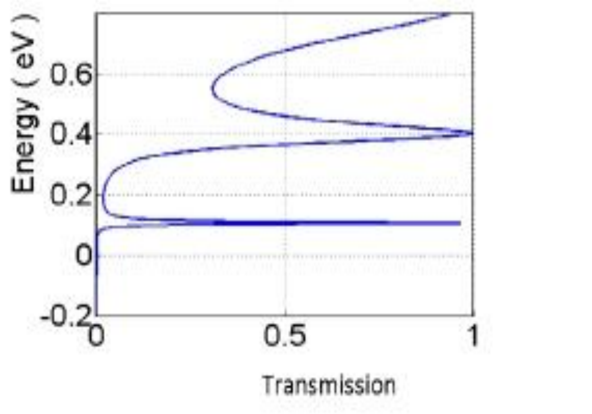

Fig 3. Changes energy in terms of transport's function

We change the three layers properties until transport function to maximize. Figure 4 shows it

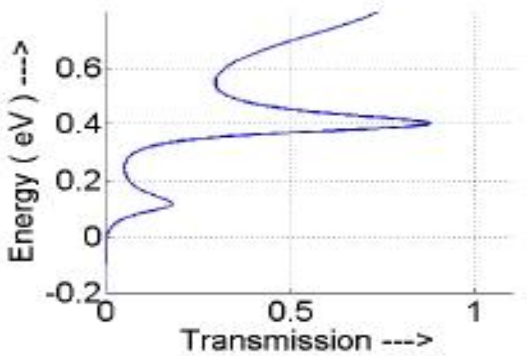

Fig 4. Changes energy in terms of transport maximum.

IV. Conclusion

It can be said summary

1. Increasing the binding strength of the electrical insulator transition probability density case, the electron density, broad levels of disruption increases.
2. Broad band connection increases the levels of disruption to electrical insulation and show non-conductive insulating state to semiconductor stat and even conductor.
3. We can control the electron transport in the non-conductive.

References

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