二維半導體雙位能障結構下
實現自旋電子分離

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摘要

我們提出在 GaAs/InAs/GaAs 三五族半導體中，自旋電子在雙位能障下穿隧的計算與研究。在考慮自旋軌道耦合的情形，加上閘極控制的雙位能障，帶有不同自旋方向的電子在通道上傳輸時，造成電流的差異。在這樣的差異下，我們可以得到一個可觀的自旋極化的數值。轉而言之，在透過適當閘極控制雙位能障和調整適合的參雜濃度下，可以將不同自旋方向的電子近乎完全的分離，此可作為全半導體自旋電子分離機制的基礎。我們的計算是建立在有效的單電子能帶哈密頓量以及 Rashba 自旋軌域作用的理論下，加之以包絡函數來描述在二維 InAs 通道上電子的波函數。在電子穿隧機率的數值計算上，使用多階近似的方式成就整個位能障的穿隧機率之計算。

此外，在我們的報告中，也呈現了各種有關於影響自旋極化的因素的探討，包含自旋軌道耦合參數、溫度和偏壓。並且呈現在這樣的元件架構下的電流電壓關係圖，在此我們說明了在每個偏壓點下電流變化理論上的因素。

Spin filtering in 2D double barrier semiconductor structures

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ABSTRACT

In this report, we propose a device made of GaAs/InAs/GaAs, and by the double gates there is a potential barrier induced on the channel. In the presence of spin orbit interaction, there is an energy difference between the opposite spin orientation electrons. That is the main reason why there is spin polarization. We could get a respectable value of spin polarization based on this structure. In advance, we can almost filter the electrons with opposite spin orientations whenever we could control the doping concentration and the distance between the double gate electrodes appropriately. Our calculation is based on the effective one-hand Halmiltonian and Rashba spin orbit interaction, and the envelope function is used to describe the

electron wave function on the channel. In the numerical calculation of the tunneling transmission probability we adopt the multistep approximation to approximate the whole potential barrier.

Besides, we also present the relations between spin polarization and the factors which could affect it. The I-V curve in such a device is also presented, and we will explain how the current varies at every bias point.