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Short Channel Field Effect Transistors and Effect of Interplay and Backscattering

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ABSTRACT We have studied the operation and properties of field effect transistors and effect of interplay and backscattering. The role of shot noise is important in this study. The shot noise is produced across the potential barrier in channel. There is no relation between barrier crossings with collective behavior during poissonian process. The interaction due to fluctuation during was examined. The transmission probability was studied. The effect of phonons was observed in crossover. The study of electron-phonon scattering was studied. The Pauli exclusion principle was considered for the study of our problem. The effect of interplay between backscattering in channel was studied. The electrostatic interactions for carriers were studied. For the study of electron-electron interaction the fluctuation of current was considered. The cases of silicon transistor and carbon based electron devices were studied. The enhancement and suppression of shot noise were studied. The repulsion of coulomb electron-electron interplay was found. The same was found in the case of electron scattering in the channel. This was due to bias in weak inversion in short channel transistors. The transport was found due to potential barrier by the source having low contact resistance. The approximations were used to obtain transport. The increase of contact resistance produced spectral density and Fano factor.

KEYWORDS Interplay, backscattering, short noise, potential barrier, transmission, fluctuation, interaction, short channel.

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INTRODUCTION

Spathis et al. [1] and Jonghwan [2] studied the operation and properties of silicon transistors. The cases of carbon based electron devices were studied by several investigators [3-7]. Navid et al. [8] and Chen et al. [9] studied that shot noise source is main part of short channel field effect transistors. It was presented in the form of carriers cross caused by potential barrier in channel. Ya et al [10, 11] and Li [12] studied experimentally and theoretically the supression of electron devices and microscopic structure of shot noise then it was found that carrier crossing were negatively correlated in behavior having anti bunching. Mazziotti et al. [13] and Davies et al. [14] formulated the field effect transistor for lowest dimensional subband and variation of subbands were studied in vertical films. Rahman and Lundstrom [15] prepared device based on electrostatics of an approximation considering the top of the barrier and dependence of potential was studied. Risho et al. [16] calculated energy of bottom of lowest two dimensional subband of channel. Lundstrom and Guo [17] computed electron density with the help of combining carrier fluxes. Rakheja et al. [18] calculated mean free path averaged over direction energy and critical length was obtained. The effective width was calculated by Lundstrom and others [19]. Park et al. [20] presented the study of conductance of oxide thin films field effect transistor. The simulation was used to calculate electron mobility and studied the function of Fano factor in response to voltages and potential barriers. Sutar [21] used a technique having four probe studied the effect of contact resistance. Xie et al. [22] presented cold source field effect transistor dependent on source density of state. The band gap of semiconductor was studied and found narrow band gap in the source region. Safarzadeh et al. [23] fabricated a field effect transistor containing graphene and generated hybrid plasmonic mode. In this study it was found high field confinement and nonlinear features of hybrid plasmonic modes. Bhattacharya et al. [24] studied the operation of organic field effect transistor and found reduction of contact resistance. The dielectric layer produced transport properties. Fiel et al. [25] presented the switching of the gate terminal of transistors and power MOSFETS. In this study it was found that the defects caused the emission of photons and were detected by substrate. The characteristics of interfacial point defect were also examined and was found that drain contact was electrically active to help operation.

METHOD

We have used a mechanism to enhance the shot noise in field effect transistors. The interplay between electron-electron coulomb repulsion and electron scattering were studied in channel. This was due to biasing of subthreshold and transport was generated in short channel of transistors. The potential barrier was developed near the source by means of contact resistance. The suppression of shot noise was studied. We have used thin film transistor structure. The height of potential barrier and current between drain and source were determined. The induction of lowest two dimensional subband was observed. The energy of the bottom of lowest subband was calculated of transistor by using the relation [16].

$$E_C = -q\left(\psi + V_{FB}\right) = -qV_{GS} + \frac{qn_s}{C_{OX}}$$

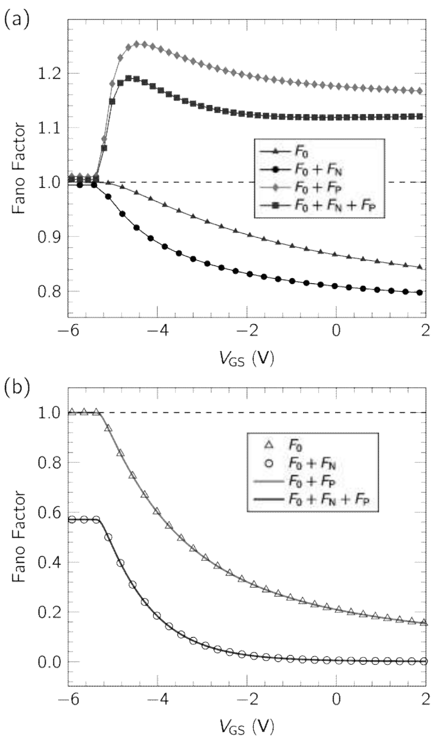
Where n_s is the electron density per unit area at the channel, V_{GS} is the voltage applied between gate and source, V_{FB} is the voltage of flat band, ψ is the potential at the channel. C_{OX} is the capacitance per unit area between the gate and the channel. The electron density was determined between the source and drain contacts. The transport was determined when current by obtained using Landauer realation [17].

$$I = \frac{q}{\pi h}\int_{-\infty}^{\infty} dE\, M\left(E\right)\left(f_s - f_D\right)\Gamma,$$

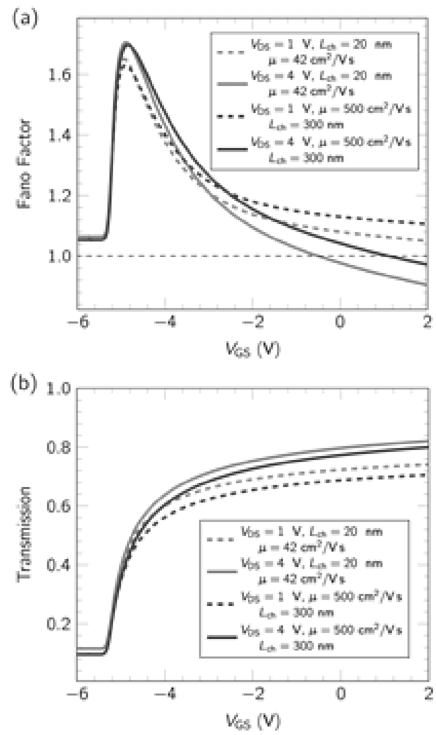
Where Γ the transmission probability in the channel is, $M\left(E\right)$ is the number of modes, *E* is the energy. Shot noise power spectral density *S* was determined. The current fluctuations were observed. The variation of energy series were obtained. The Fano factor was determined. The fluctuations of electrostatic conditions were used to study the transmission probability.

RESULTS AND DISCUSSION

We have studied the effect of short channel field effect transistor of interplay and back scattering. Graph (1) shows the plot of Fano factor of transistor as function of applied voltage. The effect of different contributions have been shown in this graph. It is also clear that the there was enhancement of Fano factor. It was also found that when energy was increased greater the Fano factor was suppressed. Graph (2) shows the plot of transfer characteristics of the device and Fano factor as a function of voltage applied. It was found that poissonian peak at gate voltages are closer to the threshold voltage and became greater and narrow as the sum of different contributions decreased. The transitions were observed in poissonian regime. The transmission as a function of applied voltage was increased when function of sum of different contribution was decreased. The effect of enhancement of shot noise was found at room temperature. The weak inversion working was found when contact resistances were sufficiently small. In case of tunneling or of non-parabolic band structure the transmission probability was obtained. The deviation of shot noise was found when correlations were taken in carrier channel crossings due to Pauli Exclusion Principle. Shot noise is useful for short-channel transistors when longitudinal electric fields moved towards higher crossings. The obtained results were compared with previously obtained results and were found in good agreement.



Graph 1: Plot of Fano factor of transistor as function of applied voltage.



Graph 2: Plot of transfer characteristics of the device and Fano factor as a function of voltage applied.

CONCLUSION

We have presented the short channel field effect transistors and effect of interplay and backscattering. We have found enhancement of shot noise in field effect transistors. Shot noise is source of short channel field effect transistors. This is produced when carriers crossed the potential barrier in channel. The suppression of shot noise was studied. The effects due to which enhancement of shot noise was interplay between carrier and backscattering in channel in the presence of coulomb repulsion among carriers. It was found that when we reduce drain to source voltage then crossings became bidirectional and current noise spectral density converted into thermal noise. So shot noise is very useful for short channel field effect transistors. The results found were in good agreement with previously obtained results.

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