Conclusion

The backgating effect in GaAs field effect transistors was modeled as a function of several parameters. They are the density and the energy position of deep acceptors and donors, the temperature and the substrate length. Since the substrate of GaAs FETs can be n or p-type, the study has covered both. Also different doping densities were modeled.

In the absence of deep levels, the conductance decreases more rapidly in np^- structure than in the nn^- structure. This is due to the decrease of the electron density in the channel of the nn^- structure to values greater than those in the np^- structure for the same voltage. The substrate current of the nn^- structure is of generation type which dominate in GaAs due to the naturally high density of g-r centers. Then it saturates after a certain voltage because of saturation of the velocity and not because of the total depletion of the structure.

Adding acceptor traps to the substrate, increases the backgating and the appearance of the generation current. The substrate current decreases due to the fact that the depletion region decreases with increasing the acceptors density.

The TFL current appears with increasing acceptors. It occurs when the substrate is more p-type but the traps are fully ionized.

The donors reduce the backgating since they make the substrate less p-type hence the depletion region inside the channel decreases. They also reduce the generation and TFL currents. The position of deep donors in the band gap is more effective when they are closer to the conduction band while deep acceptors are more effective when they are far from the valence band.

When donors are larger than acceptors they compensate and reduce their effects, hence reducing of backgating.

The channel-substrate spacing is also an important parameter since if it increases the backgating is reduced and the substrate current decreases. In this case the saturation occurs also because of saturation of the velocity, but this require higher voltages for long substrate to achieve the same velocity. It is found also that the TFl type is reduced by increasing this parameter.

In most cases it was found that the substrate current obeys the relaxation regime especially when the substrate is n-type containing a large density of acceptor traps. The TFL type (SCLc) always follows region when the current is generation one. This region is a typical for space charge limited conduction. The appearance of TFL current is more important in the structures where the substrate is more n-type. The ohmic region (constant mobility) or the saturation region (electric field dependence mobility) constitute the final stage that the substrate current takes.

As a resume and in order to reduce backgating, it is suggested to uses a substrate which is initially p-type. The dopping should be small as possible. Another parameter is adding high density of deep donors to compensate deep acceptors. The energy of deep donors should be as closer to the conduction band and that of the deep acceptors far from the valence band.

Another parameter is the increasing of substrate length but this is not suitable.

As a further work which can be done is to study the effect of biasing the drain and the gate of the MESFET. These will take a lot effort since, it must be done in a two dimension simulation. Another work to be done is the transient response of deep levels. All these can make a good doctorate project.