CHAPTER 7

CONCLUSION AND FUTURE SCOPE

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7.1. Conclusion

The electrochemical model for nanomaterial based ENFETs with high-κ dielectric as insulating material has been presented. The model was formed by dividing the device phenomena stepwise starting from the action of enzymes on biomolecules to the production of current in the ENFET. A generalized electrochemical model has been discussed with all the different key steps involved in the ENFET operation. For validation of the model, three different fabricated ENFET devices (G-ENFET, CNT-ENFET and CNT-DG-ENFET) has been used. The current transport modeling in all the three devices has been found to be different because in G-ENFET, graphene has been used as the substrate; in CNT-ENFET, CNT has been used as the substrate and in CNT-DG-ENFET, CNT has been used as the substrate but there has been current production due to dual gates. Moreover, the G-ENFET used detects cholesterol whereas CNT-ENFET and CNT-DG-ENFET, detects acetylcholine. Therefore, the acid/base reactions leading to pH variations has been found to be different in both the cases. The simulation results of all the three device models has been compared with the experimental results of the fabricated devices for validation of the model and found to be in good agreement.

From these works, it can be concluded that the generalized electrochemical model for nanomaterial based ENFETs can be used for graphene and CNT based devices with certain differences in parameter calculation. Also, it may be concluded that even if a transition takes place from Si domain to graphene and CNT domain, the basic theory and principle associated with conventional Si based ENFET devices will also be applicable to G-ENFET and CNT-ENFET devices. Therefore, it may be expected that the work presented here will help researchers to understand the device physics, explain experimental data and chose the parameters for the high sensitivity and selectivity of nanomaterial based BioFET devices for bioelectronics applications.

7.2. Future Scope

Although this thesis has presented a validated electrochemical model for nanomaterial based ENFETs for biomolecules detection, but still many more study and analysis may be included in future work, such as:

1. Developing models for nanomaterial based ENFETs, which can detect other biomolecules such as glucose, urea, creatinine, etc.

2. Developing models for other nanomaterial based biosensors such as ImmunoFETs, DNAFET, Beetle/chip BioFET, Cell-based BioFET, etc.