Direct Methanol Fuel Cells (DMFCs) are considered as the most promising power source for powering portable devices such as cellular phone and laptop computers and also automobiles and buses. The main difficulties associated with this device are the sluggish kinetics of methanol electrooxidation (MOR) and oxygen reduction reaction (ORR), poisoning of Pt electrocatalyst by methanol oxidation intermediates, particularly CO molecule and crossover of methanol molecule from the anode to the cathode compartment through the polymer membrane, these all have an adverse effect on the overall cell efficiency.

Platinum is the most active metal electrocatalyst which is used to enhance the kinetics of both the reactions, methanol oxidation and oxygen reduction, but it is pretty costly ($ 13,000 per 100 g) and has very low abundance in nature (5 parts per billion by weight). The researches have been carried out all over the world to minimize these technical problems. The research work mainly carried out into three directions: (i) reduction in the mass and CO poisoning effect of the Pt by suitable means, (ii) development of low cost, efficient and non platinum metal anode materials and (iii) development of methanol tolerant cathode materials.

Pd, being relatively low cost ($ 5833 per 100 g) and more abundant in nature than Pt, is presently being considered as a potential substitute for Pt in alkaline media for methanol electrooxidation. Efforts are continued to improve the electrocatalytic activity of Pd by suitable means. Pd has recently been produced in the form of nanosized-Pd (or Pd alloys) particles on high specific surface area carbon supports such as nanocarbon (NCs), carbon nanotubes (CNTs) and graphene nanosheets (GNS).

In the present thesis, nanocomposites of highly dispersed Pd-Co, Pd-MCo$_2$O$_4$ (M = Mn, Co or Ni), Pd-MMn$_2$O$_4$ (M = Mn, Co, Fe or Cu) and Pd-MnMoO$_4$ have been obtained on GNS, and studied their structural and electrocatalytic surface properties in relation to methanol oxidation and oxygen reduction reaction. The whole thesis is comprised of five main chapters: Introduction, Objective, Experimental, Results and Discussion, and Summary.

The Chapter 1 (Introduction) is devoted to a brief description of importance and types of fuel cells, electrocatalysis and fundamentals of kinetics, problems associated with commercialization of direct methanol fuel cells and remedial actions already under taken and
literature related to the work on MOR and ORR especially on palladium based catalysts. The Chapter 2 (Objective) presents the importance of the present investigation. The Chapter 3 (Experimental) deals with details of materials used, preparation of electrocatalysts, methodologies and instruments employed in physicochemical and electrochemical characterization of catalysts.

The experimental findings and their discussion are presented under head, Results and Discussion (Chapter 4). For convenience, this chapter has been divided in two parts: (A & B).

Part A deals with methanol oxidation study on Pd-MCo$_2$O$_4$/GNS, Pd-MMn$_2$O$_4$/GNS and Pd-MnMoO$_4$/GNS in 1M KOH + 1M CH$_3$OH and Part B deals with O$_2$ reduction on Pd-Co/GNS, Pd-MCo$_2$O$_4$/GNS and Pd-MMn$_2$O$_4$/GNS in Ar- and O$_2$-saturated 0.5M H$_2$SO$_4$/1M KOH. The important findings of the whole study are given in the concluding chapter i.e. Chapter 5 (Summary). A list of journals and books consulted are given after this chapter.