# Abstract

The thesis entitled “Carbon Materials and their Composites for Device Applications” is focused on the synthesis of carbon nanomaterials, mainly 2-D and 0-D carbon materials viz. graphene oxide (GO), reduced graphene oxide (rGO), and graphene quantum dots (GQDs), as well as their nanocomposite with conductive polymer PBTTT [Poly(2,5-bis(3-alkylthiophen-2-yl)thieno[3,2-b]thiophene)] for thin film transistor applications. Further, biomass-derived activated 2-D carbon is studied as a low-cost material for electrochemical sensing applications. The ability to synthesise nanoparticles of varied materials, sizes, and morphology, as well as quickly assemble them into complex designs, is critical to progress in these fields. Nanomaterials offer a wide range of uses due to their structural characteristics. With ramifications for contemporary research, the discovery of graphene and graphene-based polymer nanocomposites represents a significant achievement in the field of nanoscience. The advent of polymer nanocomposites has ushered in a new era in materials research. Carbon-based nanofillers, such as 2-D carbon, carbon nanotubes (CNTs), and carbon nanofibre (CNF) etc., have been used in the development of polymer nanocomposites to strengthen their thermal and electrical properties. Inherent features of graphene and graphene derivatives (graphene oxides and reduced graphene oxides etc) have sparked intense curiosity about its potential application in a wide range of devices like sensors, transparent and flexible electrodes for screens, solar cells and OLEDs etc. among the items on the list. Due to its large surface area, aspect ratio, thermal conductivity and electrical conductivity, flexibility, and electroactivity graphene as a nanofiller may be selected above other traditional nanofillers. In polymer/graphene nanocomposites, graphene's superior characteristics over polymers are reflected in devices like FETs and sensors. However, the dispersion of graphene nanosheets in the polymer matrix as well as interfacial interaction between the graphene nanosheet and the polymer matrix influence the nanocomposites' physicochemical properties. Further, the cost of graphene is another major limitation of its technological applications. As we observed a new dimension is added to this field after the introduction of 2-D carbon and carbon QDs. These materials showed enormous potential in sensors and electronic devices. In light of the foregoing, the thesis focuses on utilising the unique physical and chemical properties of carbon nanostructures, which are widely exploited in a variety of applications