PREFACE

This work discusses the physical, mechanical, thermal properties and machining performance of plain composite and nanocomposite and to identify critical microstructural parameters that affect their different properties. The composites are fabricated with the help of Hand layup technique and 3D printing method. 3D printed composites consist of onyx as a matrix material and the different reinforcements which are glass fiber, carbon fiber, high strength high temperature glass fiber and aramid (Kevlar) fiber. Onyx is a mixture of nylon (thermoplastic polymer) and chopped carbon fiber. By using the Hand lay-up method two types of hybrid composites were fabricated and those are pristine composites and nanocomposites based on two-dimensional nanomaterial (Graphene). The reinforcements are glass fiber, Jute fiber, epoxy (Thermosetting polymer) is used as a matrix material and graphene is used as a filler material. Graphene offers exceptional thermal and electrical conductivity, is lightweight, and is extremely rigid. Together with a very high aspect ratio, these characteristics make up a singular combination and nanoscale dimensions make graphene very appealing to be used as the filler in composite applications at the microscale. The efficient manufacturing of micro or meso-scale components and goods utilising graphene-based composites requires a solid knowledge foundation that will enables the fabrication of these composites to satisfy the needs of both the micro or meso scale engineering and manufacturing requirements.

Chapter 1 introduces the topic by explaining the background, motivation and history. And also gives the overview of the current literature towards the development of the thesis topic.

Chapter 2 explore the influence of nano-filler on mechanical, morphological behaviour, and material removal rate (MRR) and establish the mechanisms of MRR. The investigation of thermal properties and flame retardancy of both hybrid composite $(0^0,0^0,0^0,0^0)_S$ and $(0^0,30^0,45^0,60^0)_S$ and nano-composite $(0^0,0^0,0^0,0^0)_S$, was conducted, and a potential flame retarding technique was presented. The current study also looked at how two-dimensional nanoscale inclusions affected the way jute-glass hybrid composites responded to low-velocity impacts based on ASTM specifications. The bonding strength and physical defects on the surface of plain composites and nano-composites were analysed using a scanning electron microscope (SEM). Nanocomposite $(0^0,0^0,0^0,0^0)_S$ material has a maximum specific surface area of 2818 m^2/gm which proves that this material is better adsorbent material compared with the other two. Pristine hybrid composite samples show excellent thermal stability compared with nanocomposite.

Chapter 3 describes the notch sensitivity and fiber filament fill pattern effect of 3D-printed CFRTs. The machining performance of three different 3D printed CFRTs composite materials (GFRT, HSHTFRT and KFRT) in terms of Material removal rate when slot micro-milling. It also looked at how the composites responded to low-velocity impacts based on ASTM specifications, where the v-notch is used to evaluate the impact energy and impact resilience.

Chapter 4 investigate the elastic property of polymer composite which is helpful in structural design and then the application of this composite as in the case of boat hulls and also in the case of other automotive parts and aerospace industry which is generally facing different water condition during operation so here I have considered three water situation: seawater, acidic water, and distilled water. From the results found it was observed that the pattern of water absorption resembles non-Fickian. The maximum moisture content value (M_m) values are 11.855. Mostly, the application of this research is in the case of Boat hulls (flat, round, multi, vee, etc.) which generally face these types of water. So the design of Boat hulls, automotive parts, aerospace vehicle parts etc should be based on acidic water.

Chapter 5 studied the effect of nanotube curvature on vibrations and resonance conditions of the system and to find the best possible C.N.T. waviness inside a matrix composite beam and the composite bridge to achieve its highest natural frequencies while taking the C.N.T. volume fraction into account. To determine the optimum waviness under encastre boundary conditions and various vibration modes, a 3D F.E. model of the beam is created using ABAQUS and Python programming. The waviness impact of carbon nanotubes is substantially dependent on mode shapes, according to the results of the F.E. study. The optimal number of elements and nodes for the convergence research is currently being investigated, and it has been discovered that 19666 nodes are acceptable for producing accurate findings.