CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION OF COMPOSITES

A composite material is made from two or more constituent. One is called as reinforcement and the other is called as matrix. Reinforcement is a load bearing member and matrix is load transferring. The reinforcements in form fibers are called as fiber reinforced composite (FRC).

Some of the advantages of FRC composites are high specific strength to low weight ratio, high stiffness, corrosion resistance, tailoring of strength and stiffness properties, possibility of molding complicated into shapes, easy to repair, high dimensional stability, concept of bonded structure, smooth outer surface.

Some of the limitations of composites are poor erosion resistance, poor electrical resistance, degradation of characteristics in moisture, high cost of material, special efforts for tooling, limited workshop facilities, new inspection techniques, requirement of skilled manpower, lack of standardization and awareness, part to part variation due to non-uniform fiber volume fraction and biodegradability.

Applications of the composite includes transportation, defence, aerospace, wind mills, toys, marine, boat, building furniture, medical, civil structures and electrical engineering.

1.2 CLASSIFICATION OF COMPOSITES

Composite are made of two constituents, one is called reinforcement and other is called matrix. The composite can be classified based on both reinforcement and resin.

1.2.1 Based on Reinforcement Criterion

The strength of composite depends on type of reinforcement and amount of fibers present in the laminate. There are many forms of reinforcement and classification of reinforcement based on types of forms as shown in Figure 1.1.

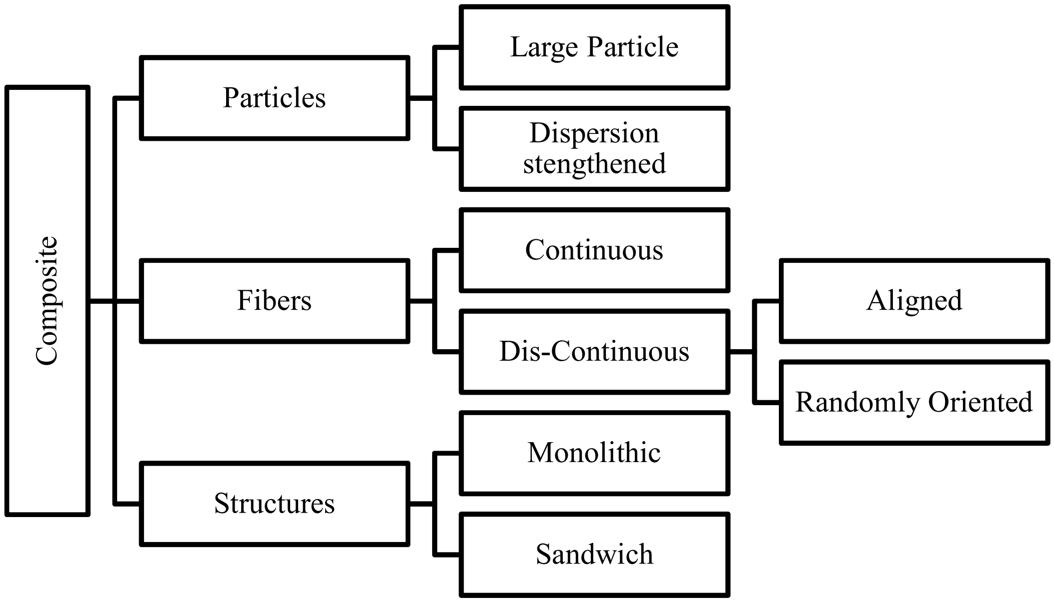

Figure 1.1 Classifications of composites based on forms

The FRC can be made by different types of fibers. The classification of fibers is shown in Figure 1.2.

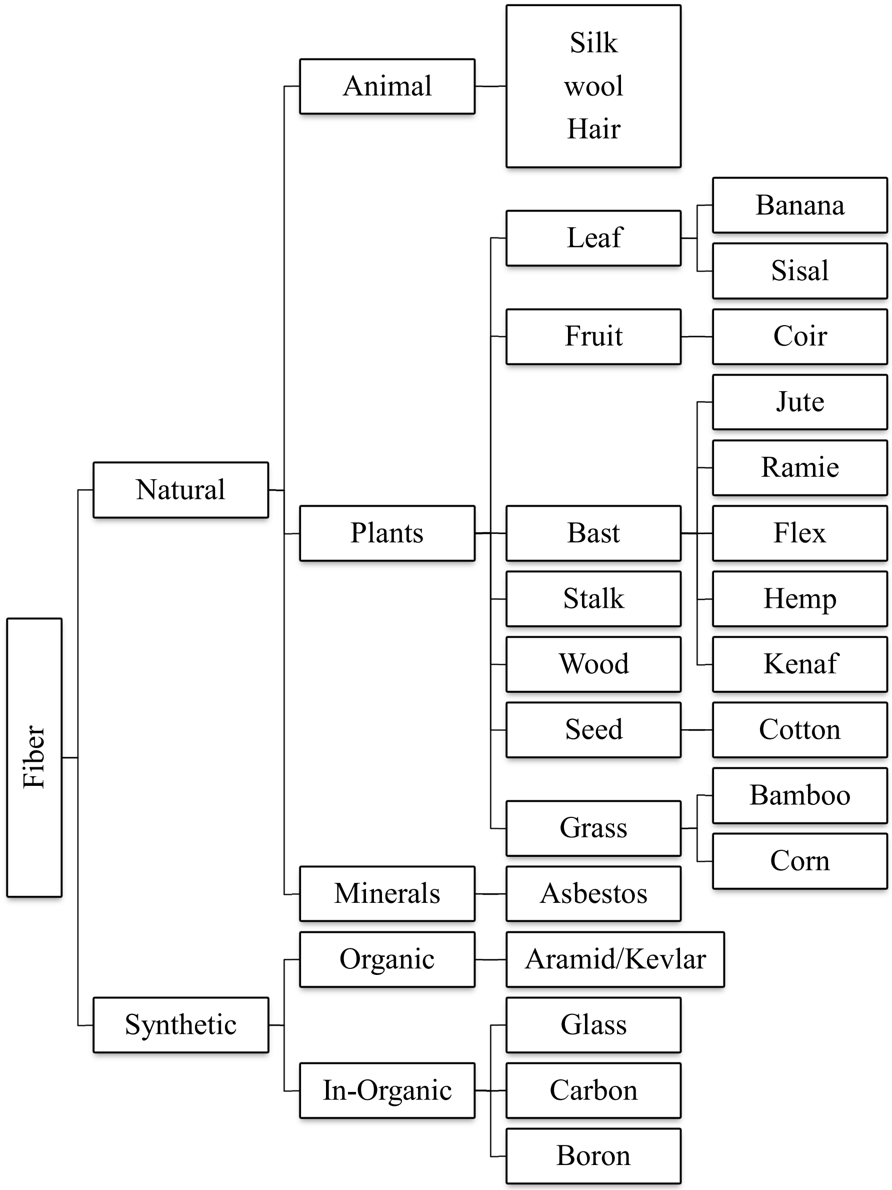

Figure 1.2 Classification of fibers

1.2.2 Based on Matrix Criteria

Based on matrix the composites are classified as shown in Figure 1.3. The matrix performs two functions in composite. First it transfers the load and second it protects the fibers from damage and atmospheric contamination. The proper bonding of matrix with fiber gives better results.

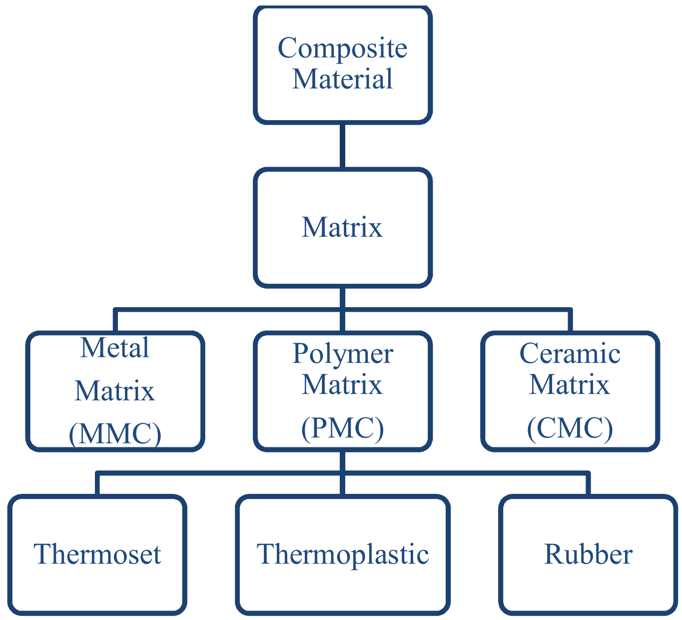

Figure 1.3 Classification of composites based on matrix

1.3 COMPOSITE MANUFACTURING PROCESSES

Fiber Reinforced Plastics (FRP) composites can be manufactured with different techniques. The selection of technique depends upon many parameters like cost, size and shape of component, type of material used, application of product etc. Figure 1.4 shows classification of FRP composites based on manufacturing techniques. In this research work we have used liquid compression molding (LCM) technique to make laminates with thermoset resin and plain weave fabric.

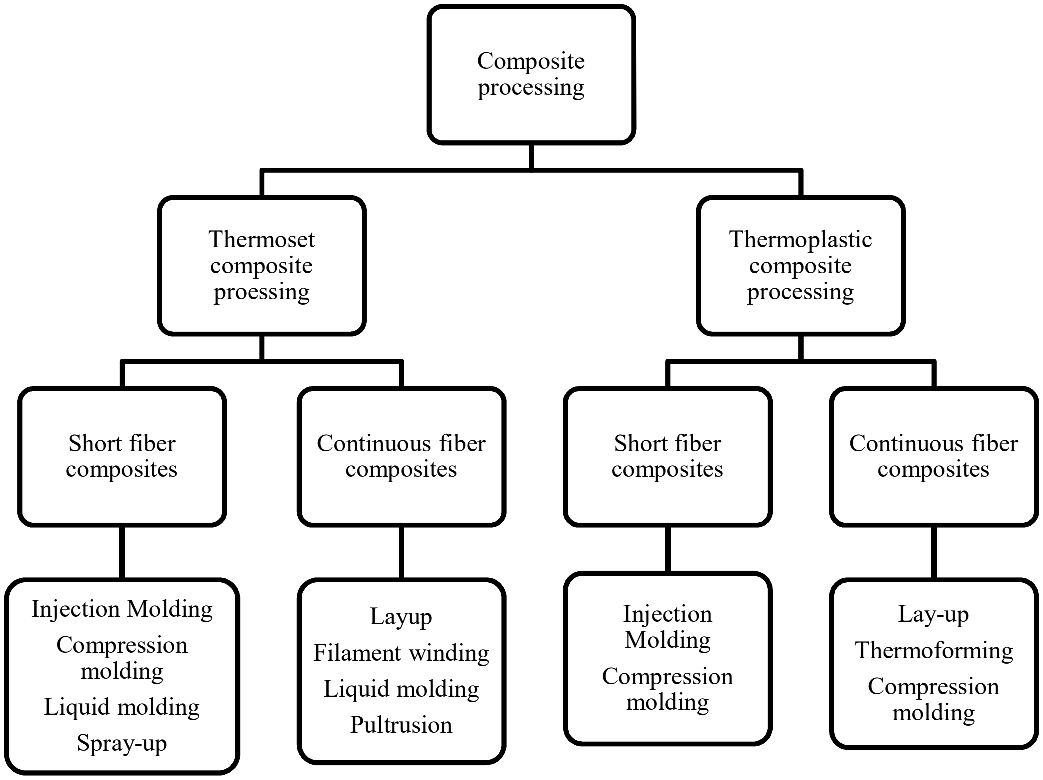

Figure 1.4 Classification of composite manufacturing processes

1.4 LIQUID COMPRESSION MOLDING

Liquid compression molding (LCM) is one of the popular composite molding processes. It is also known as wet compression molding process in which resin is poured into reinforcement by applying pressure or vacuum. LCM is used to make complicated large structure. The cost is comparatively low as it is out of autoclave process. It is close molding process and hence it is neat and safe for operator. There are many variants of this process which has been shown in Figure 1.5.

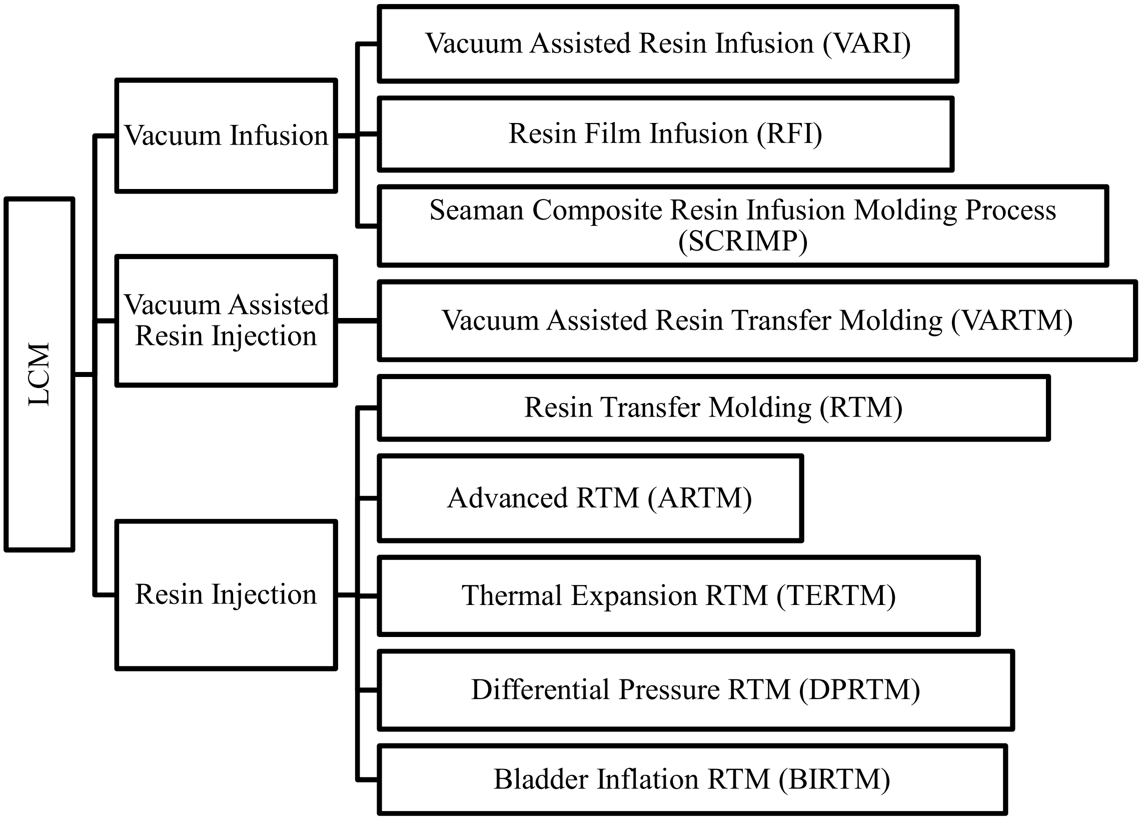

Figure 1.5 Classification of liquid compression molding processes

1.5 VACUUM ASSISTED RESIN TRANSFER MOLDING (VARTM)

This is a FRC making process and part of LCM process. The process involves use of vacuum to facilitate the resin to flow inside the fabric contained within a mold tool covered by a vacuum bag. The main steps in VARTM are mold preparation, layup, vacuum bagging, vacuum infusion and curing.

In this technique vacuum is used to drive resin into a fabric. Materials are laid dry in the mold and the vacuum is applied before the resin is introduced. Once a complete vacuum is achieved, resin is literally sucked into the laminate via carefully placed tubing.

The process is cheaper compared to part making with prepreg as autoclave is not required during curing, only single side tool is required, there is no constrain in size of the part, high volume fraction ratio can be achieved compared to hand layup, it is a cleaner process as compared to hand layup, environment friendly and un-injurious to health as the process is covered with vacuum bag and no human intervention is required after vacuum bagging and void content reduces due to vacuum supply.

However this process is considered as a trial and error process, a variation in part thickness is observed due to only one side tooling, has a complicated set up, is less consistence in production, has high consumable cost and has limited ability to achieve high volume fraction as compared to RTM. This process is used in marine application, automobile industry, aircraft industry, robot parts making, wind blade manufacturing, for making defence vehicles, boat hull etc.

Figure 1.6 demonstrates experimental setup of VARTM process.

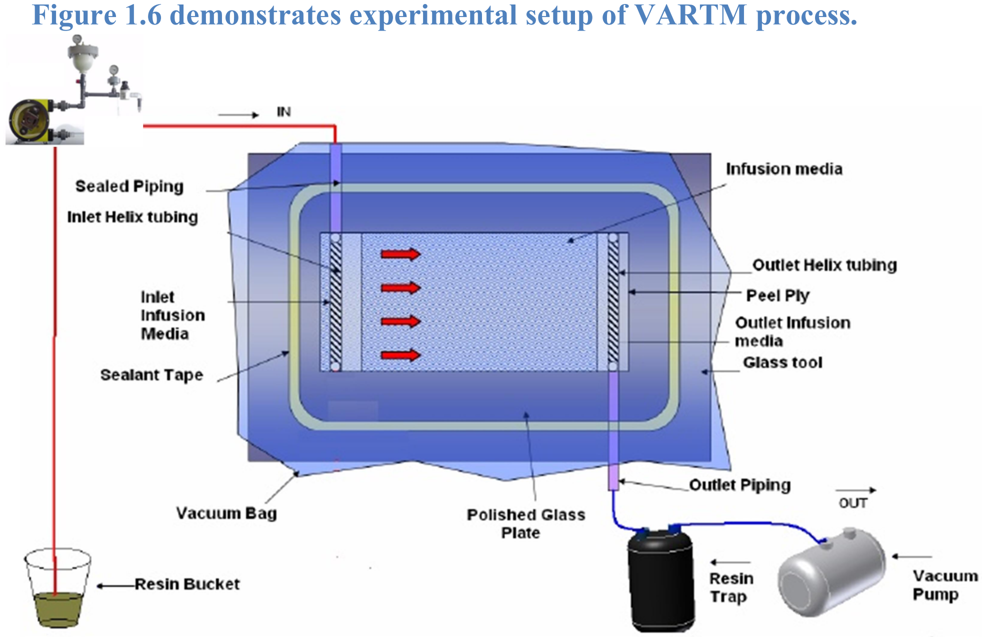

Figure 1.6 VARTM experimental setup (Dhyani, 2008)

1.6. STRUCTURE OF THESIS

The thesis is divided into seven chapters.

Chapter 1 covers introduction of composite, classification of composite based on reinforcement, matrix and manufacturing techniques, introduction of liquid compression molding and VARTM process.

Chapter 2 covers literature review on research papers related to history, introduction, natural fibers, parameters effecting VARTM process, experimental setup, effect of degassing, manufacturing and mechanical characterization. Research gaps were identified based on literature review.

Chapter 3 includes research objectives, problem statement and research methodology based on research gaps identified in Chapter 2.

Chapter 4 comprises of details of material and consumable used, care and precautions during experimentation, process steps, design of experiments (DOE) used while conducting experiments and experiments set up arrangements for sets of experiments.

Chapter 5 includes measurement and testing performed during and after experimentation.

Chapter 6 includes result analysis and discussion on sets of experiments performed as per chapter 5.

Chapter 7 summarises the conclusion derived from the present research work and future scope in this area.