In the civil aircraft industry, the application of composite materials has generally lagged behind military usage for two reasons: firstly, cost is a more important consideration to commercial aircraft manufacturers, and, secondly, safety is a more critical concern, both to the airframe manufacturer and government certifying agencies.

Meanwhile, increasing oil prices have driven the civil aircraft industry to introduce composites in commercial aeroplanes in the 1980´s. In 1980, Airbus produced the A320 with, for the first time, composite materials in the primary structure (flaps and horizontal tail plane), representing about 10% of its weight. In the recently developed A380, composites are about 25% of the primary aircraft structure weight. Structures like vertical and horizontal tail plane, centre wing box, rear fuselage and wing ribs are made of carbon fibre reinforced plastics (CFRP). In addition to the manufacturing costs and production rates, damage tolerance & damage resistance has become a major issue for the composite industry.

About 50% of the weight of the Boeing 787, which first flew in 2008, is composites, Figure 1.1 [2]. For the first time, the entire fuselage is made of composites using the prepreg tape lying technique. With this aeroplane, Boeing expects a weight saving between 20 and 25% compared to a similar aeroplane made with aluminium alloy.

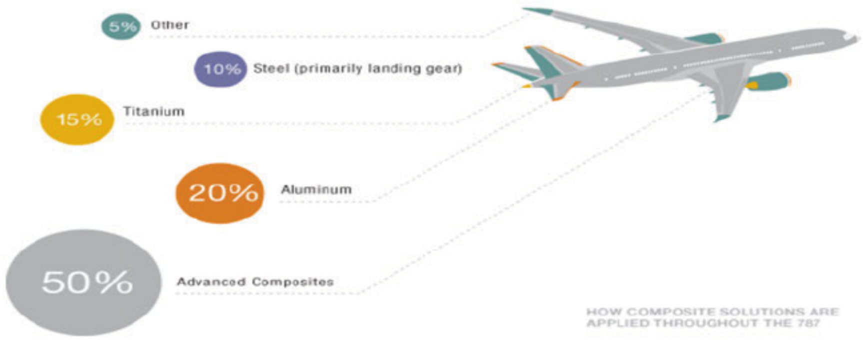

Figure 1.1: Material used in Boeing 787 (2)

Until now, the composites that are used in primary structures in the aeronautical industry are mainly made of pre-impregnated carbon fibres with epoxy resin (prepreg carbon-epoxy) that are cured under high pressure (6-8 bars) in an autoclave, however, this technology involves high material and manufacturing costs. Therefore, new materials and processing methods are being developed.

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Figure 1.2: Standard composite structure manufactured from multiple parts being assembled together.

One manufacturing technique, that is intensively developed nowadays and will be a focus of this study, consists of laying-up "dry" fibres on the desired part shape (mold) and a liquid resin being injected afterwards (RTM). This is the most promising technology for manufacturing complex structures, as well as its capability for high rate production with good quality net-shape parts. The fibres can mainly be prepared in the form of woven fabrics or non-crimp-fabrics (NCF). The liquid resin has a very low viscosity compared to prepreg resin and can, therefore, be injected either under ambient pressure (vacuum created in the "dry" part) or with higher pressure (2 to 10 bar). There are two ways to manufacture a laminate (composite) with such materials; open mold and closed mold. Open mold consists of a lower mold and a vacuum bag or membrane on the upper side. Closed mold is with an upper and lower mold.

1.2 Problem definition

The aircraft industry faces three main challenges when it comes to composite manufacturing, namely, weight, cost and quality. These challenges have pushed composite manufacturers to investigate ways to improve the standard design and method of manufacturing with out of the box ideas to solve some of the obstacles in the lifecycle of the structure. One of this obstacles is impact; during the life of a composite aircraft structure, impact by foreign objects often occurs during manufacturing, service, assembly, maintenance operations and flying. Some of the challenges as mentioned before are the

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