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A Review of the Mechanical Joining Techniques for Thermoplastics

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Abstract

Nowadays the use of thermoplastic materials has been increasing steadily because of its positive effects on vehicle weight which is directly related to fuel consumption. This paper presents a literature review of joining methods for thermoplastic materials and classifies the methods according to the structure of the joining technique. Within this context, more than 10 studies about mechanical joining techniques for thermoplastic materials are considered. In mechanical joining techniques, materials are bonded by using some physical methods such as clipping, riveting, etc.

Introduction

In recent years, the use of thermoplastics has increased significantly in automotive industries, aircraft structures and in other high-performance engineering applications, including wind energy structures, sporting goods, and medical appliances. One of the main reasons for moving from purely metallic structures toward composite structures is the possibility of tailoring their performance to the structural requirements. Using thermoplastic composites gives the advantages of their high fracture toughness, better environmental resistance, and recyclability [1]. However, the thermoplastics have to be joined with appropriate techniques to have proper structure.

The joining of thermoplastic composites is an important step in the manufacturing of components, especially in structural application. This structure can be showed avaries of irregularities which can result in weakening of the properties [2]. Joints are necessary always when part integration is impossible because of complexity and high cost, using different materials in the same component, disassembly is required, and repair of damage is needed [3]. The methods for thermoplastics joining can be joined three main categories: chemical joining techniques, mechanical joining techniques, and thermal joining techniques. This paper presents a mini literature review of mechanical joining methods for thermoplastic materials and classifies the methods according to the structure of the joining technique.

Mechanical Joining Methods for Thermoplastics Materials

Joining is a critical step in the manufacture of components, especially in structural applications. Joints are needed when: part integration is impossible due to complexity, using different materials in a structure, disassembly is required and repair of damage is needed. There are many important considerations for joint design in composites which: reliability and repeatability, anticipated life, operating environment, geometry of the parts and type of loading applied to joint [4]. In mechanical joining techniques, the materials are bonded by using some physical methods. There have been introduced various mechanical joining techniques in literature and grouped as follows:

a) Mechanical Fasteners (screws, bolts, and rivets, etc.), is a device that is used to mechanically join two or more objects together. This joining technique is one of the least expensive, most reliable and commonly used joining methods for assemblies that must be taken apart a limited number of times [5].

b) Self-Piercing Riveting technique, which has been developed for joining of both similar and dissimilar materials, provides considerable structural straight with high efficiency [6]. Self-piercing riveting methods is a process

based on the insertion of a rivet into two or more sheets with no preparatory hole [7].

c) The clinching technique, similar to the self-piercing riveting method, joins the sheets by local hemming with a punch and die, but without a rivet. In the process of clinching

d) Techniques, an interlock is formed between the sheets by the different amounts of material deformation which create a round button on the material [8].

e) Thread-Cutting Screws cut the thread during the assembly process which means that every time the screw has assembled some material that will be cut away [9-11].

Kagan & Weitzel [12] dwelled on basic principles in material selection for thermoplastics applications. The material selection for assembled thermoplastic parts is an important process in the designing and manufacturing for automotive applications. In this study, proposed fastener(s) material replacement (from steel to aluminum) will allow managing the stiffness considerations of, short-term (strength) and long-term (life) performance. The results of this investigation provide recommendations on materials pre selection for the design of fastened thermoplastic components with improved mechanical performance. Subramanian and Senthilvelan [13] is studied static and dynamic joint strength performance of discontinuous glass fiber reinforced polypropylene leaf spring with steel plate. They found out that long fiber leaf spring joint has better performance during high cycle fatigue conditions than short and unreinforced leaf spring joint.

Conclusion

This paper introduces a literature review on mechanical joining techniques of composite materials. As a result of the study, it can be concluded that the usage of the thermoplastic materials will rise up in the near future, especially for the automotive industry. Therefore, the joining techniques are critical issue in this field to get efficient usage of these materials. Due to its great potential to get weight and cost reduction in manufacturing, the researches on the joining techniques should be expanded.

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