Chapter 6
Joining Techniques Like Welding in Lightweight Material Structures

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ABSTRACT

In order to take more stringent measures in fuel economy and achieve the determined performance targets, the automotive industry needs to reduce the weight of the vehicles it produces. For this reason, all automobile manufacturers have determined their own strategies. Some manufacturers use lighter aluminum, magnesium, and composite components in their cars. In this study, the joining techniques of lightweight materials such as welding and the processes of their industrial use have been examined. There is currently no single technology that can combine all metallic panels in a car body structure. However, it is known that various joining technologies are used together. With the potential to combine certain combinations of steel and aluminum, manufacturers and scientists continue to work to identify technologies with the highest potential for lightweight joining and put them into use in high-volume automobile production. Therefore, it is important to examine the weldability of light materials such as magnesium, titanium, and aluminum.

INTRODUCTION

The concept of the design cycle (Hevner, 2007) which is used for technological design and industrial application areas, is an artistic concept that defines our civilization development. Simon (Simon, 2019) describes the nature of this cycle as generating design alternatives and evaluating the alternatives against requirements until a satisfactory design is achieved Today's current technological designs evoke new needs in the field in which they are used. These new needs trigger new designs. At this point, the potential of realizing new designs is limited to the level of scientific knowledge offered by materials science. If the material and technical support that will bring the new design to life is provided, the new design

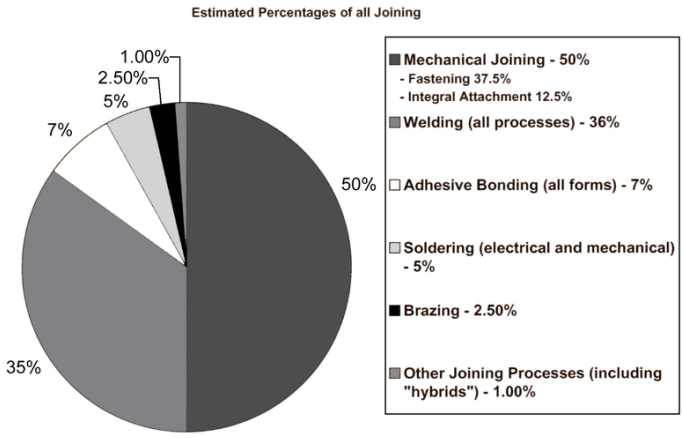
DOI: 10.4018/978-1-7998-7864-3.ch006

can come to life. Otherwise, it is necessary to find a new material for the new industrial design. These searches for new materials are the main driving force of development in the scientific world. However, even if a new material design has functions to meet the needs, it cannot be expected to turn into an industrial design immediately. Engineering solutions(Fergus et al., n.d.) come into play for the effective and efficient use of the material and ensure that the material developed for industrial integration becomes usable in applications.

With the rapid development of science and industry technologies, the sustainable development trend of the automobile industry such as environmental protection, energy saving and light manufacturing is increasing (Feng et al., 2016). The automotive industry, guided by European CO2 emission laws, is willing to increase energy and raw material costs. It faces the challenge of developing lighter and at the same time still rigid but affordable and crash-resistant car bodies for large-scale production. The application of weight-reduced structures does not depend solely on the availability of lightweight materials and related forming technologies. However, it also depends on cost effective and multi-material design and reliable joining technologies (Sathishkumar et al., 2021). At this stage, all of industry, such as the automotive, aerospace or maritime industry, and even every design has its own specific manufacturing conditions (Kleiner et al., 2003).

When deciding on the joining technique in manufacturing processes, many factors are evaluated together and a conclusion is r:eached. Considering these factors, such as physical and mechanical properties of the materials to be joined, outdoor conditions, joint construction and joint costs, determining the ideal joint type requires a difficult selection process. However, depending on the sector and material type, it may sometimes be necessary to stick to a single joint type, or it may be necessary to choose from a very small number of joining technologies. Figure 1 shows a graph showing the estimated percentages of all joins performed with the various options.

Figure 1. A pie chart showing the estimated percentages (based on dollar or dollar-equivalent value) of all joining accomplished by the various options; mechanical joining (including fastening and integral attachment), welding, brazing, soldering, adhesive bonding, and various hybrids of these (Messler, 2003).



As the energy needs of the automotive and aerospace (Ward-Close & Froes, 1994) sectors increase, intensive work is being done on the mitigation of vehicles in order to improve fuel economy, reduce