Joining: methods and techniques for polypropylene composites

M. Steiner

During the last five decades, much research was devoted to polymers and polymeric composites, starting with material development via chemical and physical modification (e.g. fiber reinforcement) and ending with new processing technologies. In the field of long or endless fiber reinforced thermoplastic composites (TPC) with polypropylene (PP) matrix the glass mat-reinforced (GMT; see also ‘Glass mat reinforced thermoplastic polypropylene (GMT-PP)’ in this book) and commingled yarn-based systems (see ‘Commingled yarns and their use for composites’ in this book) have achieved considerable market share.

In order to close the gap between possible technical application of endless fiber reinforced composite material and the actual practice, limited by consolidation and forming processes, various joining techniques were adapted and developed for glass fiber reinforced PP (GF/PP).

The production of a finished complex engineering part is technologically and economically rarely viable. Nevertheless, considerable efforts are made to integrate some manufacturing and processing steps in line. The interested reader is advised to read the chapter ‘Integrated manufacturing’ in this book. It is more straightforward to produce simply designed and shaped components which are assembled to a complex part afterwards (Figure 1). For that purpose, different methods of joining exist, which are widely used in polymer and metal processing, and which can also be adapted to fiber reinforced polymeric composites. Figure 2 gives a general overview of the different methods.

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The joining techniques (except mechanical fastening) used at present are suitable only for fiber reinforced polymeric composites with a maximum fiber volume content of 35%. If the fiber volume content is higher, joining of the fiber reinforced composites may result in a drastic decrease in the seam strength (especially in case of welding). For joining of advanced composites (i.e. with very high reinforcement content), mechanical fastening is preferred. The use of elements, such as screws and rivets etc., not only leads to additional weight, but also weakens the material through notch effects (holes, cut-outs which reduce the load bearing capacity acting as stress concentrator sites).

Gluing, adhesion bonding (see also ‘Adhesive bonding of polypropylene’ in this book) has to be ruled out, because in most cases the bond strength of glued polymeric composites is not sufficient or very large.