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Abstract

A self-reinforced PLA composite has been manufactured using a non-woven textile produced by CETI by the dry layup technique. The compression molding technique was adapted to manufacture a complex-shaped demonstrator. During the performing step, the preform exhibited no draping defects. The composite had no visible defects and was easy to demould. This demonstrator proves that these non-woven preforms can be used in industrial production of composites.

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1 Introduction

Compression molding (CM) is a well-adapted manufacturing technique for plastic and composite products in many industrial sectors owing to its high volume production rate. The advantage of this process is that it requires a shorter preparation time and can be mostly automatized to ensure the same processing conditions for every part produced using CM. CM calls for high equipment costs in terms of heating systems and molds, however, and the part size is also limited to 1 m. Thus, this process is mostly used for manufacturing small parts with complex shapes. The process should be optimized by adjusting several parameters, such as mold closing speed, consolidation pressure, and mold temperature, for each new material, to obtain a high quality of final products and avoid manufacturing defects. In the case of self-reinforced thermoplastic composites, since both reinforcement and matrix are made of the same material, the difference of the melting temperature between the reinforcing phase and the matrix phase plays an important role in the selection of mold temperature. In the current project, SEABIOCOMP, the PLA nonwovens were developed by CETI, France. The compression molding parameters were optimized previously and were discussed in D 1.2.5. In this report, we present the methodology to produce a complex-shaped demonstrator with PLA non-woven fabrics.



Figure 1: Layup of PLA non-woven fabrics in the mould

2 Materials

To manufacture a demonstrator, the dry laid SRPLA nonwoven fabric with an areal weight of 150g/m² developed by CETI, France, was used. The non-woven fabrics were cut to the mould dimensions and were stored at 23°C and 50%RH for a duration of 24 hours. The non-woven fabric layers were then stacked on each other and were transferred into the mold (see Figure 1). Each preform contained approximately 24 layers.

3 Compression moulding

Compression moulding of SRPLA composites was carried out using a hydraulic press (PEI, France) with a capacity of 120 tons. The mould resembles a curved stiffener with high draft angles (see Figure 2). The mould can be heated via two routes; one with an external heating system that uses oil as a heating agent, and the other by using the heating coils embedded into the mould. The compression cycle used in this study was optimized in a previous study (refer to D 1.2.5). After the non-woven preform was placed into the mould, the mould was closed partially by maintaining a gap of 150mm between the upper and bottom platens. The mould was then heated to 100°C, and the gap was decreased to 50mm (see Figure 3). Once the mould reached a constant temperature 155°C, the consolidation cycle shown in Figure 4 was applied. The mould was then cooled immediately using air and water (below 100°C) as cooling agents.

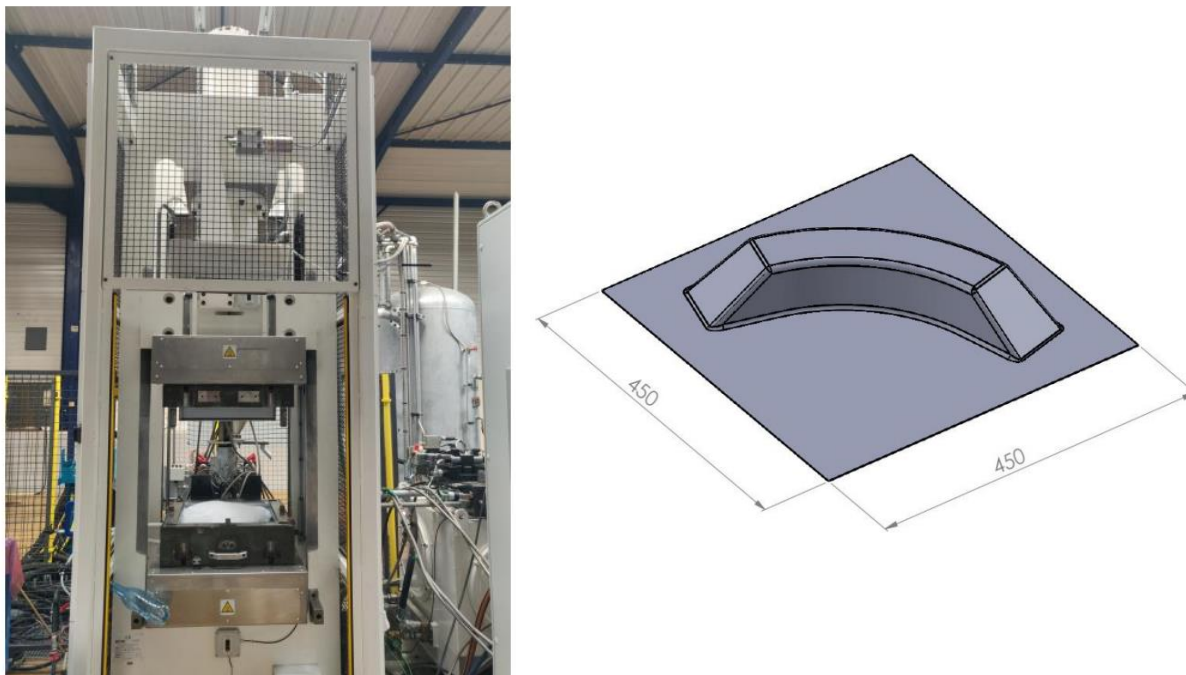


Figure 2: Hydraulic press used for compression moulding (left); CAD image of mold geometry and dimensions (right)

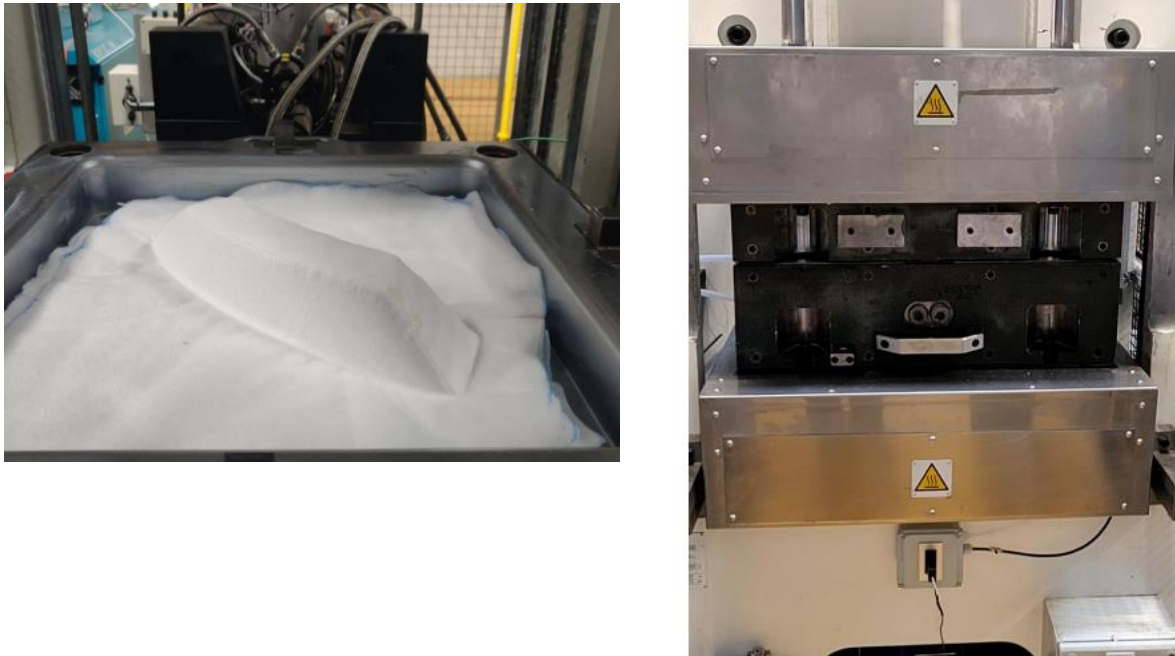


Figure 3: Manufacturing steps: Preforming of self-reinforced PLA non-woven fabrics (left); Partial closing of mould at room temperature (right)

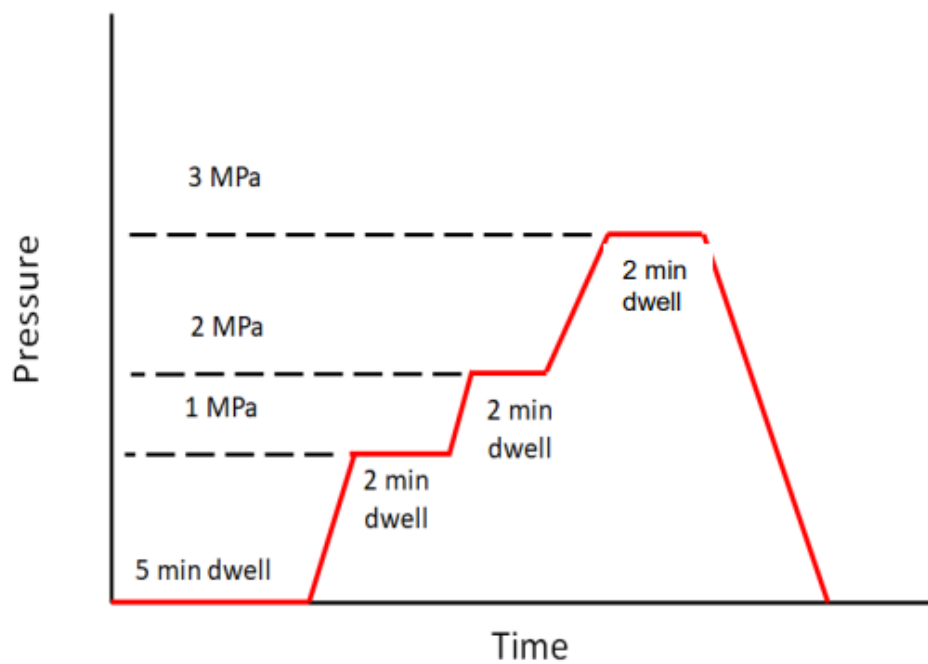


Figure 4: Consolidation cycle for SRPLA composites

Once the cooling step was completed, the SRPLA composites were demoulded at 40°C. The final manufactured demonstrators are shown in Figure 5. It can be noticed that there are no wrinkles or any draping defects in the composite. Furthermore, owing to the nature of SRPLA composites, no dry zones were observed in the composite. It can be noticed that the edges of the composite are a bit frayed and dry. This was caused due to the shrinkage of the preform. Moreover, because the preform thickness was lower, it was not totally compacted, thus resulting in a partial dry zone. This will be machined out, however, during the real production.

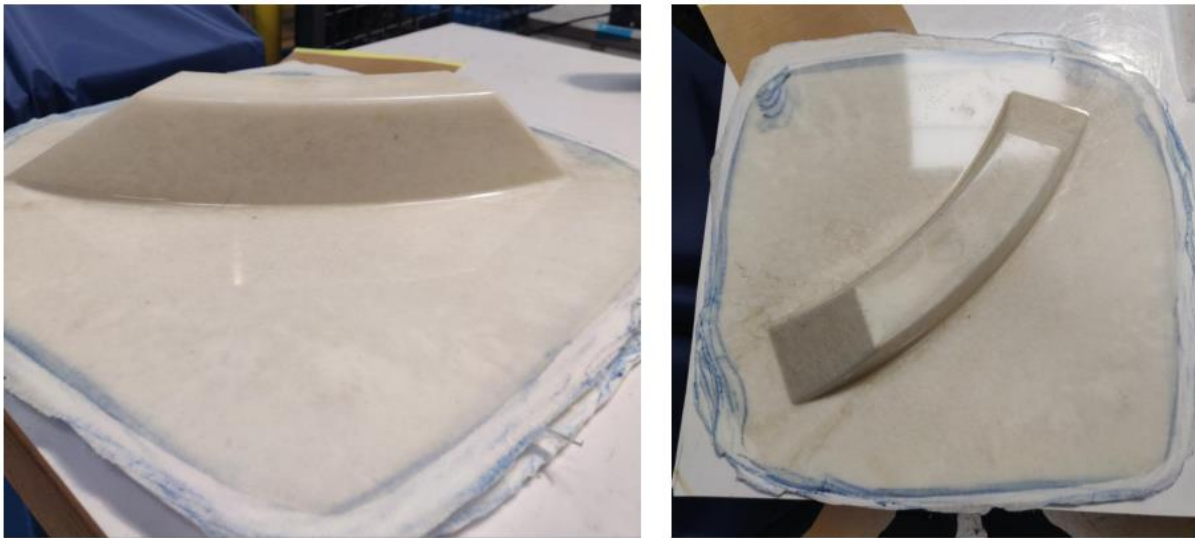


Figure 5: Self-reinforced PLA composite demonstrator

4 Conclusion

In this report, an SRPLA demonstrator has been successfully produced using the novel self-reinforced PLA non-woven fabrics developed within the project. It was identified that these nonwovens can be easily draped into complex forms without great difficulty and were easy to handle. The demonstrator exhibits no visible defects.