Automotive Thermoplastic Composites: A Manufacturing Review

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Thermoplastic Composites

- Introduced in the Automotive Industry during the 1980s.
- Several advantages over other materials.
- Mass production – a real prospect.

Figure 1: Underbody car panel made from thermoplastic composites [1].

Manufacturing Processes

- **Thermoplastic Resin Transfer Moulding (T-RTM)**
  - Introduced by researchers at Fraunhofer ICT, Germany.
  - Derived from conventional RTM for manufacturing thermoset composites.
  - Allows mass production of stronger and lighter vehicle composite materials.
  - Cycle times < 20 minutes – enabling production of up to 100,000 parts per year.

Figure 2: showing the process diagram for “In- Situ Inject” Process [2].

Tailored Fibre Placement (TFP)

- Automated and low cost textile process.
- TRP principle consists of roving pipe, base material and stitching unit.
- Fibres are aligned along the stress field in the composites.
- High accuracy, increased productivity, less fibre wastage.

Figure 3: TFP principle [3].

[3]. Tailored Fibre Placement-Principle, Leibniz Institute für Polymerforschung, Dresden, Germany. Available from: http://www.ipfdd.de/Tailored-Fiber-Placement-Principle.446.0.html?&L=0
• Adapted Injection Moulding
  
  • Researchers developed a prototype for mass-production of continuous fibre reinforced thermoplastic composites using injection moulding technique.
  • Fully automated system.
  • In-situ polymerisation.
  • Offers high flexibility and reduces manufacturing time.

Figure 4: Injection moulding compounder [4].

Manufacturing Processes

• Linear Vibration Welding
  o For joining two parts.
  o One part is fixed and the other vibrates.
  o Mechanical friction and shear stresses.
  o Heat + Pressure.
  o High scale production rates, short cycle times and ease of automation.

Figure 5: Schematic of linear vibration welding [5].

Future Development

• SpriForm
  o Combining thermoplastic injection moulding and continuous fibre-reinforced thermoplastic thermoforming.
  o Focuses on cost-efficient manufacture of thermoplastic-based FRPs suitable for mass production.
  o Suitable for large scale production of components with improved energy absorption properties.

Figure 6: SpriForm process [6].

Conclusion

• Thermoplastic processing methods depend on nature of matrix and reinforced materials.

• Manufacturing methods to meet safety standards and satisfy customer’s expectations.

• Energy-efficient and highly automated processes.

• Increased robustness and recyclability.