Multiaxial Non Crimp Fabrics for Reinforcing Thermoplastic Composites and Sheet Moulding Compounds

Steven Bakker
SAERTEX GmbH & Co. KG, Saerbeck, Germany, 2016 November 21st

Abstract:
Thermoplastic composite materials as well as Sheet Moulding Compounds (SMC) are now more and more in focus as a weight-saving alternative for sheet metals, enhancing the mechanical properties of components made by injection or compression moulding. Here the use of Multiaxial Non-Crimp Fabrics as textile reinforcement creates a widely untapped opportunity. Current Sheet Moulding Compounds are mainly reinforced by chopped strands mats (CSM) from glass fibre. Thermoplastic composites are either reinforced with CSM or with continuous glass or carbon fibres, where the continuous fibres significantly improve the specific mechanical properties. These fibres are predominant in the shape of a woven fabric or as unidirectional (UD) tapes and impregnated by molten polymer to a composite.
Non-Crimp Fabrics (NCF) offer flexibility in the fibre orientation and areal weights in each layer of the fabric, therefore the optimal amount of reinforcement can be oriented in the exact load direction. NCF consists of a multi-layer structure that can be manufactured in a single step. Additionally spreading roving's enables to produce fabrics with a very smooth surface. Composites reinforced by Non-Crimp Fabrics form an excellent supplementary product to currently available materials. Furthermore Non-Crimp Fabric reinforced composites are suitable for components with high demands concerning surface quality and mechanical properties at the same time.

State of the Art
In thermoset applications Non-Crimp fabrics are being extensively used where high mechanical properties are required. Fields of applications are ranging from aerospace, to wind energy and exclusive automotive applications.
Mass-production automotive materials like SMC are still primarily based on chopped fibres and thermoplastic composites use either woven fabrics or UD Tapes, increasing the complexity of making multiaxial layups and being very vulnerable to fibre disorientation during the part pressing stage and are therefore limited to certain geometries.

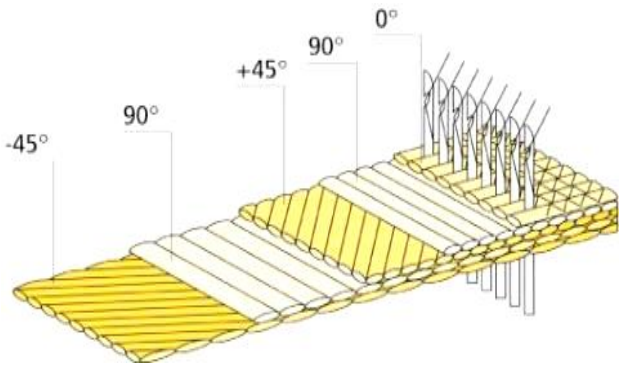

Fig. 1: Non-Crimp Fabric

Advantages of Non-Crimp Fabrics
Non-Crimp Fabrics (NCF) offer optimal fibre orientations and area weights per layer in a multi-layer structure, manufactured in a single step (see Fig.1). Subsequent procedures, like the stacking of single tapes or single fibre layers are not necessary. The orientation of the weft threads in a Non-Crimp Fabric can be freely selected within a range of 90 ° to ± 22.5 °, allowing an optimal use of the fibre properties. Therefore the total thickness of a component can be further reduced. During fabric manufacturing polymer films for later impregnation can be integrated between the single fabric layers.
Spreading rovings also enables to produce fabrics with a very smooth surface. The influence of shrinkage of semi-crystalline polymer on surface quality can be significantly reduced.

Field of applications
Cause of their notably mechanical properties Non-Crimp Fabric reinforced organic sheets and Sheet Moulding Compounds are predesignated to carry complex loads. For stiffening highly stressed structures, carriers or profiles Non-Crimp Fabrics open up new possibilities of lightweight construction.
Furthermore Non-Crimp Fabric reinforced composites are suitable for components with high demands concerning surface quality and mechanical properties at the same time. Here they can offer new ways in the field of interior and exterior applications.

Experience in processing
NCF have been successfully transformed into multiaxial reinforced SMC and thermoplastics and excellent mechanical values have been obtained, confirming the potential of these materials in numerous automotive applications.