7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Experimental simulation of twisted carbon tows friction during weaving process

Julie Walther, Michel Tourlonias, Mathieu Decrette, Sascha Krügl and Marie-Ange Bueno

Université de Haute Alsace, Laboratoire de Physique et Mécanique Textiles (UR 4365), F-68200 Mulhouse, France

An experimental simulation of the contact between tows during the stage of shedding in weaving process is presented. The tribometer was developed to allow angular friction between two tows, with a yarn tension variation device. Studied parameters are friction forces, yarn tension, contact angle and finally data resulting from image processing analysis such as the amount of broken fibres. The influence of yarn cohesion during friction, by applying twist to carbon tows, is highlighted. Results show that a 22 or 33 tpm twist increases the stability of 12K carbon tows during friction, contrary to tests performed on untwisted yarns.

Keywords: carbon twist friction weaving yarn-to-yarn

1. Introduction

Composite materials reinforced with carbon interlock-based woven fabrics are common in the air and space industry [1]. Nevertheless, the weaving process generates high levels of yarn-to-yarn and yarn-to-loom friction due to the tows warp density in the interlock weaving process [2]. Many defects may be observed such as wear (filaments breakages), tow decohesion, and tow breakages in the long term. Moreover, surface defects and mechanical property loss also occur on the composite material. Because of these effects and in order to lower their generation, the efficiency of the weaving process is reduced and costly.
Recent studies in our lab have been focused on warp yarn-to-yarn interactions in the harness, during shedding in order to apprehend the damage generation phenomena [3]. Specific tribometers were developed for the experimental simulation of the contact between tows. This present study follows this point of view through friction experiments performed on twisted or untwisted carbon single tows. The aim is to look closely at the effect of yarn decohesion during friction, by determining the impact of the twist.

2. Methods

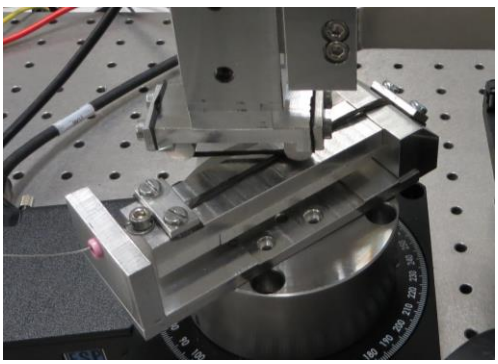

Figure 1: View of two carbon tows in contact during a test performed on the tribometer

Experiments based on friction between tows are handled on a specific tribometer (Figure 1) developed in order to measure directly the friction forces as a function of normal forces, yarn tension and contact angles. Experiments are supplemented by periodic top and side views of samples, which allow monitoring the variation and evolution of friction forces linked to fibres breakages and filament reorganization.

3. Results and Discussion

Figure 2 shows a classic evolution of normal force peaks during a test of friction composed of several cycles between two carbon tows. The slight decrease which can be observed may be partly due to the reorganization of fibres because of their mobility. The twisted yarn, in orange on the graph, is less deformed during friction owing to its higher dimensional stability. Highest peaks that occur on untwisted yarns friction test correspond to a high degradation of the yarn, like a broken fibres cluster, which increases the thickness and so the normal contact force between the two samples.

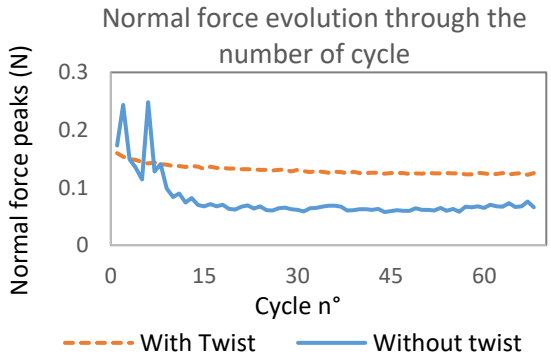

Figure 2: Evolution of normal force peaks during an angular friction test between two twisted or untwisted carbon tows.

4. References

[1] Mouritz, A.P. et al. "Review of applications for advanced three-dimensional fibre textile composites", Composites Part A: Applied Science and Manufacturing, 30, 12, Dec. 1999, 1445–1461.
[2] Florimond, C. et al. "Identification of Fibre Degradation due to Friction during the Weaving Process", Key Engineering Materials, Jun. 2013, 416–422.
[3] Walther, J. et al. "Yarn Damage Conditions Due to Interactions During Interlock Weaving Process: In-situ and In-lab Experiments", Applied Composite Materials, Aug. 2021.