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► **To cite this version:**

Moussa Gomina, Antoine Barbulee, Joel Breard, Davy Duriatti. Modeling Draw Process of Flax Fiber. 4 th INTERNATIONAL CONFERENCE ON NATURAL FIBERS 4 th ICNF -Smart Sustainable Solutions, Jul 2019, Porto, France. pp.1-2. hal-02395076

**HAL Id: hal-02395076**

**<https://hal.science/hal-02395076>**

Submitted on 5 Dec 2019

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## MODELING DRAW PROCESS OF FLAX FIBER

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### ABSTRACT

In this study we experimentally determined the length distributions of the fiber bundles after each drawing. The detailed analysis of bundles lengths distributions before and after each drawing made it possible to understand the modes of rupture and to determine their kinetics of shortening and refining. Interestingly, the refining of the rovings is accompanied by a decrease in the rate of bark (set of very hydrophilic compounds), which will promote the wetting of the fibers by the polymer during the implementation of the composite and thus will improve significantly the hydric behavior of the material.

### INTRODUCTION

In the composites industry, it is essential that the linear density of fibers (expressed in *tex*, i.e. the mass in grams of one kilometer of fiber) be perfectly controlled because the balance of the fabric depends on it. However, in the case of plant fibers, the linear density of the tape at the end of combing fluctuates according to the supply at the entrance. Draw is the industrial process of refining a roving to obtain a lower and more consistent count. A thinner roving gives better strength and flexibility to the fabric, allows easier infiltration of the resin and provides a more homogeneous structure to the composite, which improves its mechanical performance and life. During successive draws, the fiber bundles in the dry roving are stressed in tension, compression and in-plane shear, resulting in a degradation of the mechanical strength, thus inducing premature ruptures during weaving. It is therefore important to study the morphology of the fiber bundles as a function of draw.

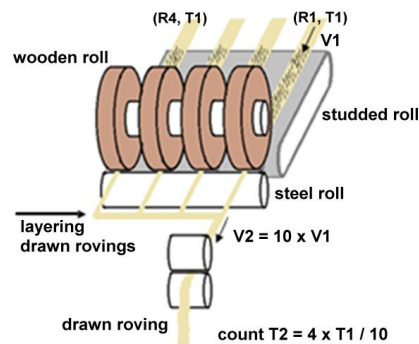


Fig.1 Diagram of the drawing device

From a combed tape with count  $T_1$ , an industrial draw device is used to obtain a finer roving with count  $T_2 = p \times T_1 / q$  ( $p$  is the number of rovings with count  $T_1$  at the input and  $q$  is the ratio between the output speed and the input speed (Fig. 1)). At the  $n$ -th draw, it will be possible to produce a roving with count  $T_n$  much smaller than  $T_1$ . To determine the length distributions of the fiber bundles in the roving according to the draw we used a testing setup

purposely built in our laboratory for plant fibers. To describe the changes in the length and fineness of the fiber bundles, we have used the volume distributions instead of the frequency distributions used by some authors (Martin, 2014) because the mechanical contribution of a bundle depends on its length and cross section area.

## RESULTS AND CONCLUSIONS

Figure 2a shows experimental values of average fiber bundles lengths and associated standard deviations, as a function of draw. The average length decreases with a loss of about 2 cm after each draw and the relative standard deviation of the dispersions is 44%. The analysis of the distributions of fiber bundles broken transversely (shortening) or longitudinally (refining) are shown in Figures 2b and 2c, respectively. The combination of these results makes it possible to represent the changes in the aspect ratio of the fiber bundles (average length / mean diameter ratio) as a function of the drawing (Figure 2d).

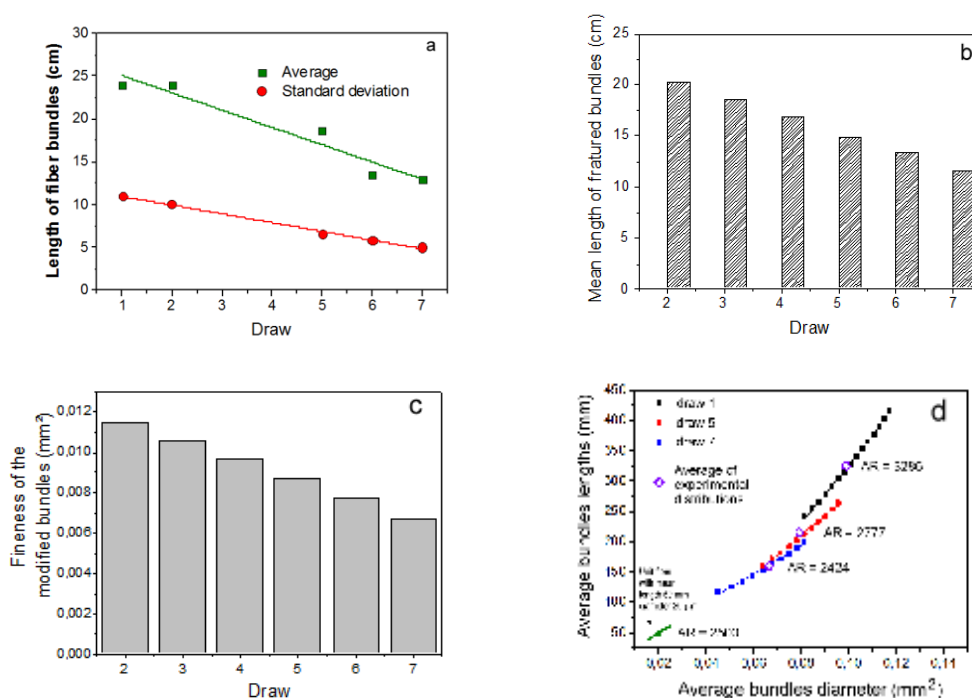


Fig.2 Evolution of average bundles lengths in rovings (a), details of transversely broken (b) or longitudinally broken (c) bundles and variation of aspect ratio as function of draw (d)

This study thus allows predicting the morphology of the fiber bundles during draw, which is an important input for the manufacture of reinforcements for composites. Future work will focus on the structural and mechanical characterization of the draw rovings.

## ACKNOWLEDGMENTS

The authors gratefully acknowledge the funding of PIAVE *TRAMPLIN* project by BPIFRANCE, France, under contract n° 130852.

## REFERENCE

Martin N, Davies P, Baley C. Comparison of the properties of scutched flax and flax tow for composite material reinforcement. *Ind Crops Prod*, 2014, 61, p. 284-292.