Investigation of Carbon Fiber Spreading Mechanism Using a Doctor Blade System


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Introduction

Unidirectional carbon fibre-reinforced polymers are strong, stiff and lightweight. These material properties make them attractive to a variety of industries, including aerospace, marine and automotive. In manufacturing unidirectional tapes, thermoset or thermoplastic polymers can be used. Thermoplastic polymers have certain advantages over thermosets such as ability to be remelted and reformed, recyclability and sustainability. On the other hand, the high viscosity of the thermoplastic polymer makes direct melt impregnation challenging, especially at high fibre volume fractions. One way to address this, is to impregnate the dense fibre bundles with a water-based polymer slurry rather than molten polymer: polymer-based particles are suspended in water as transfer liquid which spontaneously penetrates fibre bundles due to its low viscosity and strong capillary action, followed by water removal, and melt consolidation. Nip roll is one of the techniques that uses the slurry impregnation method in TU Delft tape line setup (Fig 1a). In the nip roll setup, carbon fibers are in between two papers and touches the rollers followed by water evaporation step in drying bridge (Fig 1b). Understanding spreading behavior under the influence of surface interaction and at the drying bridge are essential points for achieving well impregnated fibres.

In this research, we specifically focus on the carbon fibre spreading behavior using a doctor blade setup designed to mimic the nip roll method.

Aim: The main aim of this research is to mimic nip roller setup to investigate how fibre type, paper substrate, surface tension, and surface roughness influence fibre spreading behavior. Additionally, plat heater is incorporated to simulate evaporation conditions in a drying bridge and to evaluate the effect of liquid evaporation on fibre spreading.

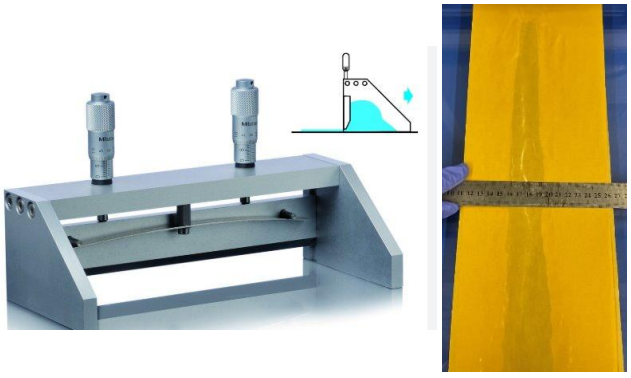
Activities & Expectations

To reach the aim of the research study, the activities needed to be performed are listed below.

- Perform experiments with a doctor blade setup.
- Characterize the elastrocapillary behavior based on surface – fiber interaction.
- Investigate the effects of fibre spreading on varied fibre type, liquids, speeds and tensions.
- Investigate the influence of evaporation on the spreading in between varied paper types.
- Characterize the resulting spreading behavior and analyze the influence of process parameters based on volume fraction and fiber distribution.

This study will enrich your understanding of unidirectional carbon fibre-reinforced thermoplastic composite manufacturing methods, colloids, heat transfer and fluid mechanics. Moreover, you will be familiar with characterization methods.

The student is willing to learn new concepts. Background in composite has an advantage but not necessary.



This work is suitable for Master students. Sounds interesting? Please get in touch!