Development of tow-spreading technique to achieve ultra-thin carbon fiber-PEEK tapes

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Introduction

Unidirectional carbon fiber-reinforced polymers are strong, stiff and lightweight. These material properties make them attractive to for aerospace application. Thermoplastic polymers have high toughness and the ability to be remelted and reformed, making them a more sustainable option. Thermoplastic prepreg tapes are the basic functional unit used for constructing large structural components like aircraft wings. Modern aircrafts are evolving to further enhance performance by reducing the weight and improving aerodynamics. Morphing technology allows integration of multiple segments while allowing freedom of movement due to high elastic strain and structural integrity. High fiber volume fraction and ultrathin thermoplastic tapes are necessary for manufacturing morphing structures.

High fiber volume fractions tapes, which are needed for structural applications are manufactured using slurry-based impregnation where polymer particles are suspended in water as transfer liquid which spontaneously penetrates fiber bundles due to its low viscosity and strong capillary action, followed by water removal, and melt consolidation.

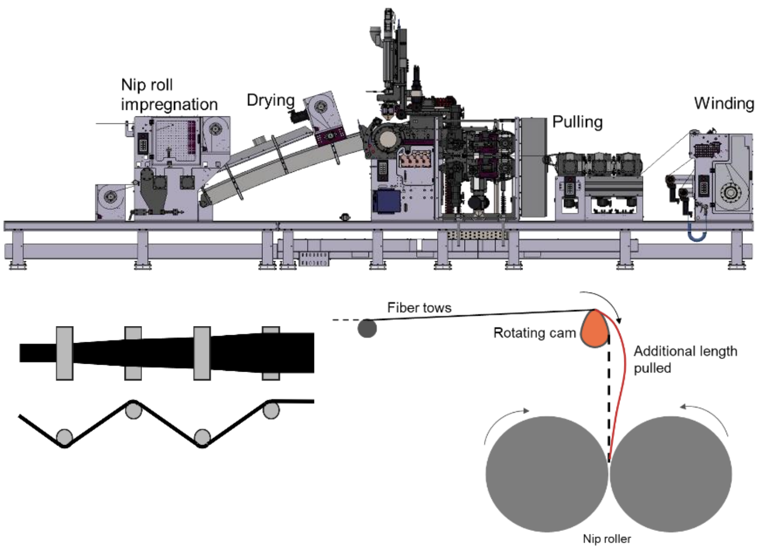
At TU Delft, thin ply high fiber volume fraction prepreg tapes are realized using kiss or Nip roll techniques in combination with a spreading mechanism (Fig 1). The final thickness of the tow is driven by a combination of mechanical spreading (using tensioning or detensioning) and hydrodynamics (especially in case of nip roller).

Aim: The aim of this project is to design and optimize the spreading mechanism to achieve thin ply tapes, and determine the optimum processing conditions to achieve continuous and stable production of thin ply tapes.

Activities & Expectations

To achieve the aim of this project, the following activities need to be performed:

1. Define the parameters for mechanical spreading system like wrap angle(s) and cam mechanics
2. Define the correlation between mechanical spreading parameters with manufacturing parameters like pre-tension, line speed, nip-roll gap and fiber volume fraction.
3. Correlate tape microstructure with spreading and impregnation unit parameters.
4. Determine design and manufacturing parameters for continuous manufacturing of thermoplastic tape
5. Suggest (or demonstrate) in-line monitoring techniques for continuous verification of tape quality and level of spreading.



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