Mechanical property characterization of ultra-thin thermoplastic CF/PEEK tapes for morphing application

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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.

The tapes for morphing application are expected to have high structural integrity and high elastic strain. The out-of-plane (flexural) properties are critical and the damage development in both the tape and the laminate can differ significantly from thick-ply laminates due to size effects. Furthermore, the microstructure of the tape can also influence the mechanical properties of the tape and laminate.

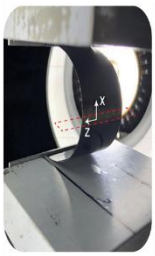
Aim: The aim of this project is to develop a numerical or analytical model representing the mechanical tests at tape scale and laminate scale, and validate this model through experimental analysis. The damage development also needs to be studied in conjunction with the microstructural variation in the thin-ply tape.

Activities & Expectations

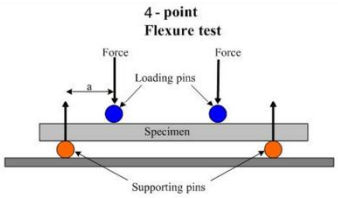
To achieve the objectives of this project, the following activities need to be undertaken:

1. Develop a numerical or analytical model representing the tape testing setup illustrated by Schlothauer et al. [1] (Fig 1a) and laminate testing using modified 4-point bending test.
2. Compare damage development in thin vs. thick ply tapes using numerical modelling.
3. Develop a mechanical testing jig for tape testing based on [1], and set up 4-PB test for desired laminate thickness based on numerical modelling
4. Validate the models against the experimental results for tapes produced at TU Delft TapeLab (Fig 1c), using Digital image correlation for damage development analysis.
5. Correlate tape thickness and microstructure with mechanical characteristics.

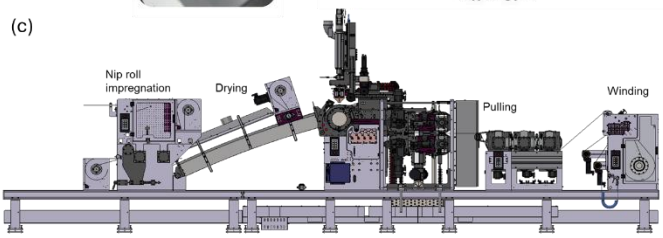
(a)



(b)



(c)



Note: This project may be divided among two master students.
This work is suitable for Master students. Sounds interesting? Please get in touch!