Structure-property relations for high performance ultra-high molecular weight polyethylene fibers

MSc assignment

Introduction

Avient Protective Materials (APM) produces high-performance fibers via hot drawing of solution-spun ultra-high molecular weight polyethylene (UHMWPE) fibers, Dyneema®. This provides fibers with a strength even up to 4.5 GPa and a density lower than water, making it a very stiff, strong, and lightweight synthetic fiber. These characteristics make it suitable for a wide range of demanding applications, ranging from for example on one hand combining yarns in ropes to fix windmill platforms or cables for cranes to lift heavy cargo, to on the other hand usage of the fibers in composites to stop bullets with helmets or bulletproof vests and other ballistic applications.

The exceptionally high modulus and strength of these fibers are a result of severe orientation of the molecules and crystals, that is obtained by specific conditions during processing. To optimize the production process and the resulting properties, it is important to understand what the properties of the fiber are at any moment in the drawing process, and how properties develop under specific conditions. This involves properties relevant during drawing (high temperature), as well as the properties relevant for most applications (ambient temperature).

Next to characterizing the mechanical properties, to better understand what drives certain performance the aim is to add morphological details, such as crystallinity and orientation distribution, and create fundamental understanding what the relation is between structure – properties.

Assignment

The graduation assignment will aim at understanding the relationship between structure and property for UHMWPE fibers, investigating how both develop during processing, and link it to properties of the final product performance. APM has the possibility to also prepare samples on lab scale, offering potential to consistently evaluate the effect of very sophisticated parameter variations that are usually not accessible for academic research.

The assignment encompasses the definition of the scope of the assignment, experimental analysis (mechanical and morphological), and modelling. The work will be carried out at the labs of Twente University in close cooperation and supervision of APM. If desired, it is also possible to perform (part of) the assignment at the APM facilities in Geleen or Heerlen, The Netherlands.

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About Avient Protective Materials

Avient Protective Materials is a business group within Avient that produces high-performance fibers spun from ultra-high molecular weight polyethylene. The high strength and stiffness with low weight are proven valuable for a wide range of demanding applications, ranging from ropes or cables for mooring and cranes to composites to stop bullets with helmets or bulletproof vests and other ballistic applications.

To guide product and application development, a large variety of research activities are on-going within Dyneema®'s Innovation Department. This covers the entire spectrum including processing the material, the resulting fiber properties, and its performance in applications.

The Innovation department is located in Geleen, The Netherlands.