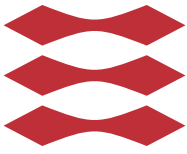


# On the Microstructure of High-Performance Polymer Materials

DTU



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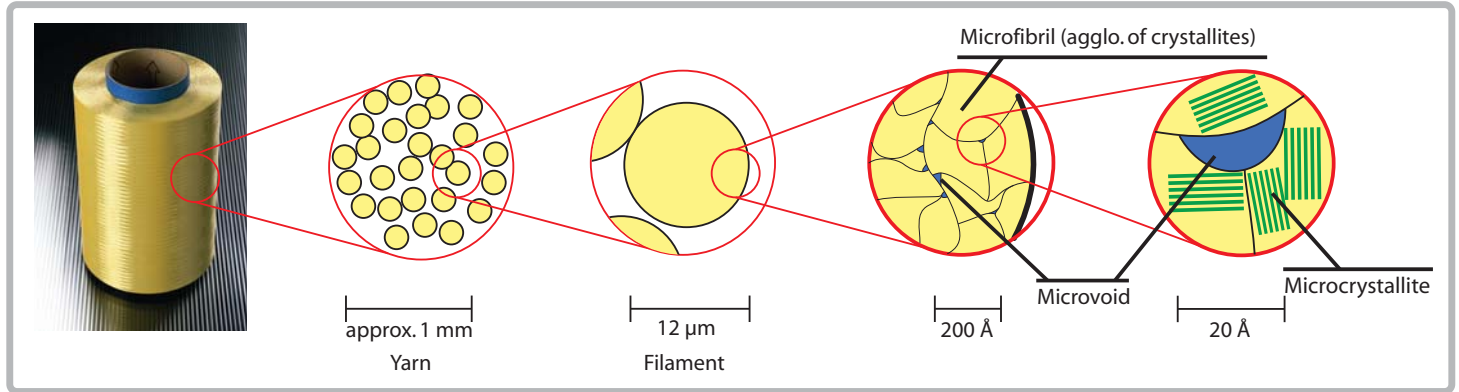


Figure 1: Microstructural elements of Twaron® at various levels of size. Leftmost image courtesy of Teijin Twaron.

## Introduction

High-performance fibres such as Twaron® and Kevlar® have severely impacted the fibre market with their versatility and unparalleled performance since their appearance 30-odd years ago. Such fibres have also captured the interest of many researchers, and many aspects of the fibres have been investigated. However, whilst individual techniques have been applied to characterise the microstructure, no concatenation and comparison of these results has been published.

## The Application of SAXS

Small-Angle X-ray Scattering (SAXS) will play a central role in these investigations. This technique excels for its lack of requirements for the sample and the validity of the data over the entire irradiated area.

SAXS has been extensively applied in the past to investigate the microfibrillar and micropore structure of many types of fibres. However, these techniques required many assumptions in order to simplify and linearise the data to make it suitable for parameter extraction. Thus, the methods developed in the past will benefit from revisions, to make them more suitable for the analysis of fibres.

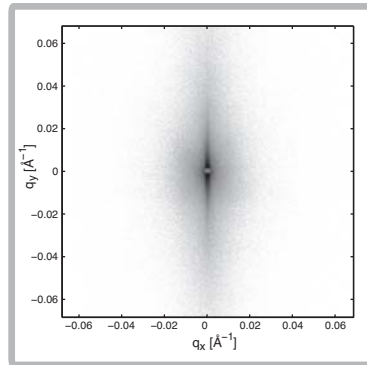


Figure 2: Twaron 1000 scattering pattern, showing a high degree of preferential orientation of the scatterers.

## The Aim of the Project

The aim of this project is to provide an uncompromising and authoritative methodology to the determination of the microstructure of high-performance polymer materials. For this, many techniques (e.g. light scattering, (electron) microscopy and nitrogen absorption, c.f. Figure 3) will be applied, in order to verify, support and complement a complete view of the microstructure of such high-performance fibers.

## In Search of Clarification

One issue which will be clarified, is the question whether or not aramid yarns have a pore structure at all. Some say the contrast originates from amorphous and crystalline parts, and not from the vacuum of the pores and the polymer material.

Another issue is the determination of whether the effects of the orientation distribution of the aligned scattering elements can be separated from the effect of the size distribution in SAXS.

Lastly, structure-property relationships are to be investigated at the end of the project. This should indicate whether the microstructure has a measurable influence on the physical characteristics of the end product.

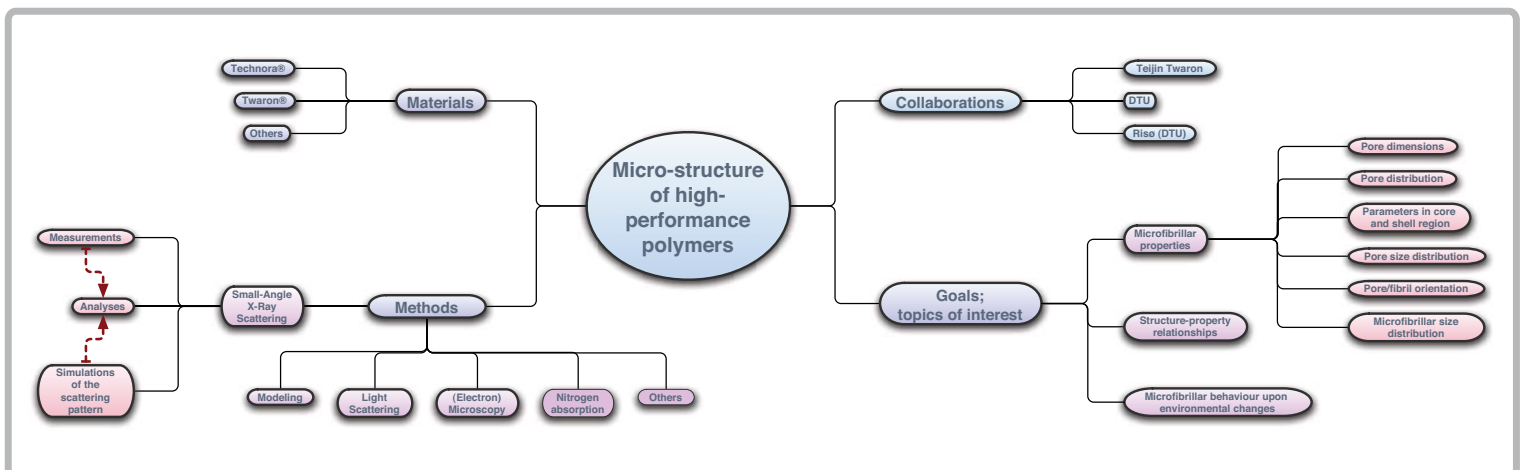


Figure 3: The project scope at a glance.