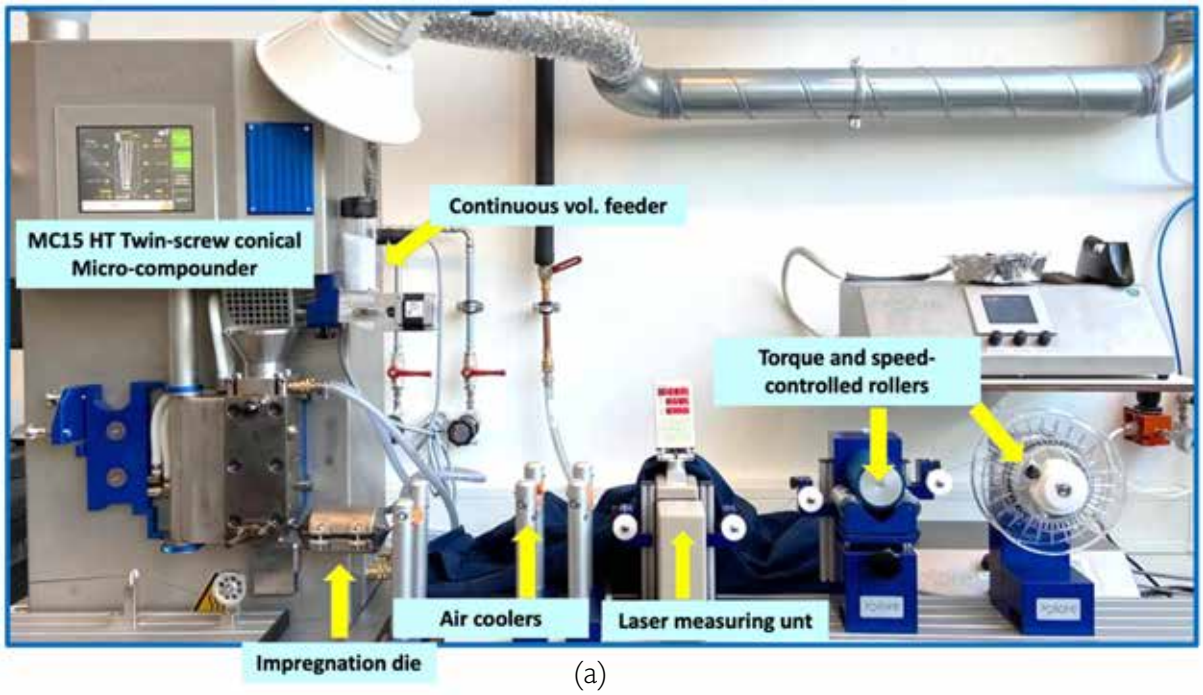
INFO NOTE

Faster and effective R&D with Xplore's impregnation line:

Long Fiber Reinforced Thermoplastics (LFT) via Coating or Impregnation

The impregnation of continuous fibres refers to the process of saturating or coating continuous strands of fibres with a thermoplastic in thermoplastic composite manufacturing. This process is crucial for creating composite materials, where the fibres provide strength and stiffness. In contrast, the matrix material binds the fibres together, transfers the stress applied to the article to the reinforcing fibres, and protects against environmental factors. Proper impregnation ensures uniform matrix material distribution within the composite, affecting the finished product's mechanical properties, durability, and performance. Insufficient impregnation can lead to voids, dry spots, and weak points in the composite, compromising its structural integrity. Current research focuses on overcoming the challenges of the impregnation process, such as resin wetting and penetration, controlling the resin content, environmentally friendly resin-fibre combinations, and material compatibility. 3D printing of the composites using continuous fiber-based filaments (so-called continuous fiber-filament additive manufacturing, CFAM) is one of the technologies where the impregnation process plays an important role.

The printable endless filaments are structures where a thermoplastic matrix either coats or impregnates reinforcing the fibres. Xplore's novel micro-impregnation and coating line allows scientists to investigate their research challenges using a small amount of material. From development, the development of the filament to the performance of the 3D printed test sample takes only a few hours. The micro-impregnation line of Xplore (Figure 1) consists of a spring-loaded de-winder where the carbon, glass, or natural fibre tow is released under tension towards the impregnation die. The impregnation die is equipped with ceramic, conical spreader bars that facilitate the tow to spread in the melt polymer (Figure 2). Any thermoplastic resin, such as PP, PA, PC, PEI or PEEK, can be fed by the micro-compounder in a controlled manner. Xplore's pressure RPM loop ensures constant throughput. The exit die of the impregnation unit can be customized to control the filament diameter. At the exit, the filament is cooled down by cooling pillars. The diameter of the filament is measured and controlled using a laser device. The line speed is defined by the speed of the take-up roller (pulling unit). And finally, the filament can be wound on a torque-controlled spool.



(a)

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Figure 1. a.) Xplore micro tow impregnation line, b.) a full spool of CFAM filament

(a)

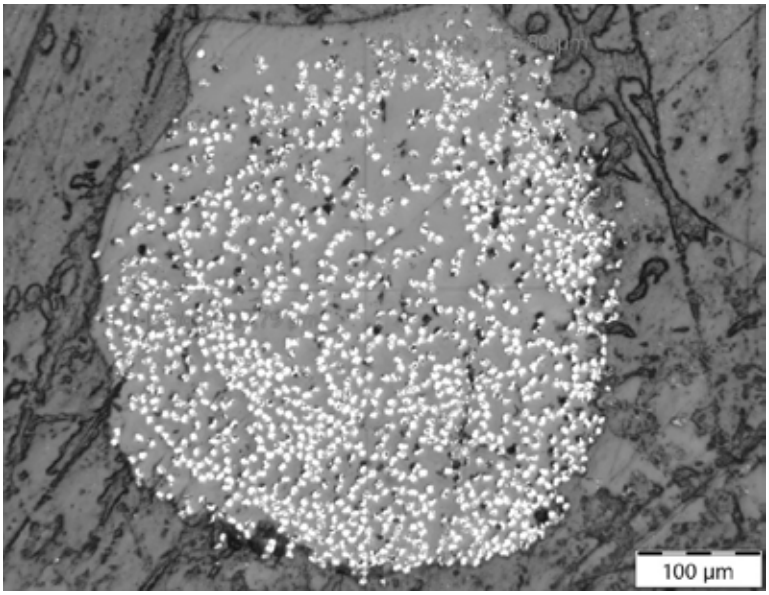
(b)

Figure 2. a.) The conical ceramic spreader bars, b.) the demonstration of the spreading of a 2k carbon fibre

The Xplore micro-tow impregnation line results in thoroughly wetted (impregnated) and well-distributed filaments in a thermoplastic matrix that is ready to be printed into a test sample.

The impregnation die can go up to 450^{O}C, which allows you to handle high-temperature polymers, such as PEEK or PPS, easily. Figure 3 shows representative microscopic images of PPS and PC-based filaments.

Xplore enables you to accelerate your research on material transition. LFT composites combine high stiffness, strength, and toughness for injection-molded thermoplastics. You can screen different formulations with various polymers using our coating die. Just interested in coating a fibre bundle? Of course, Xplore has also a solution for that challenge; we offer a coating die at a cost effective price.



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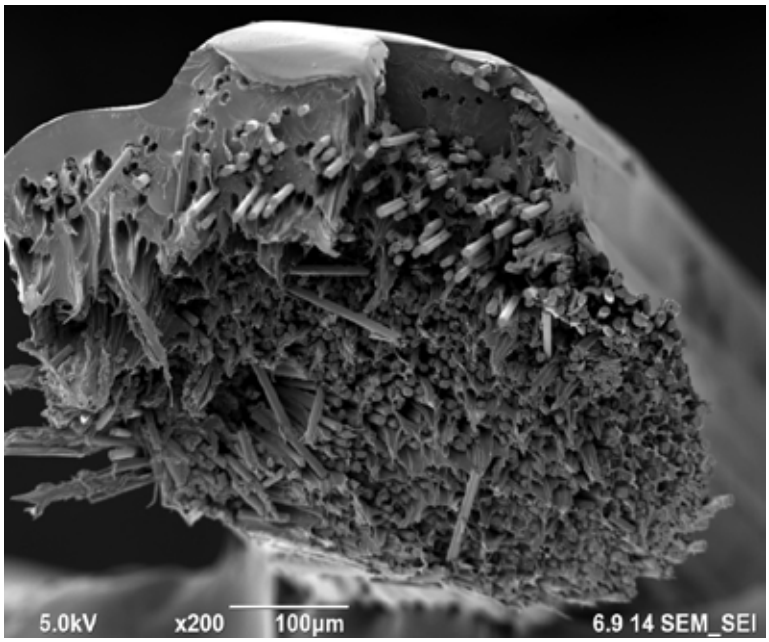

(b)

Figure 3. a.) The cross-section of a 2k carbon fibre – PPS filament
b.) SEM cross-section of a 2k carbon fibre – PC filament

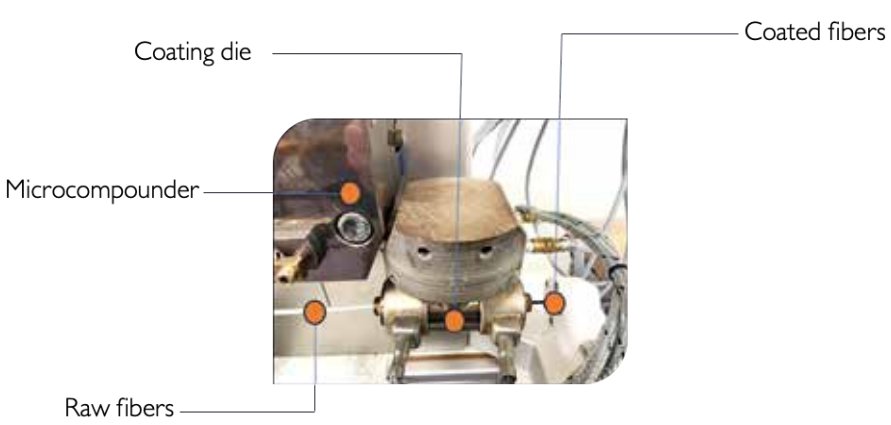

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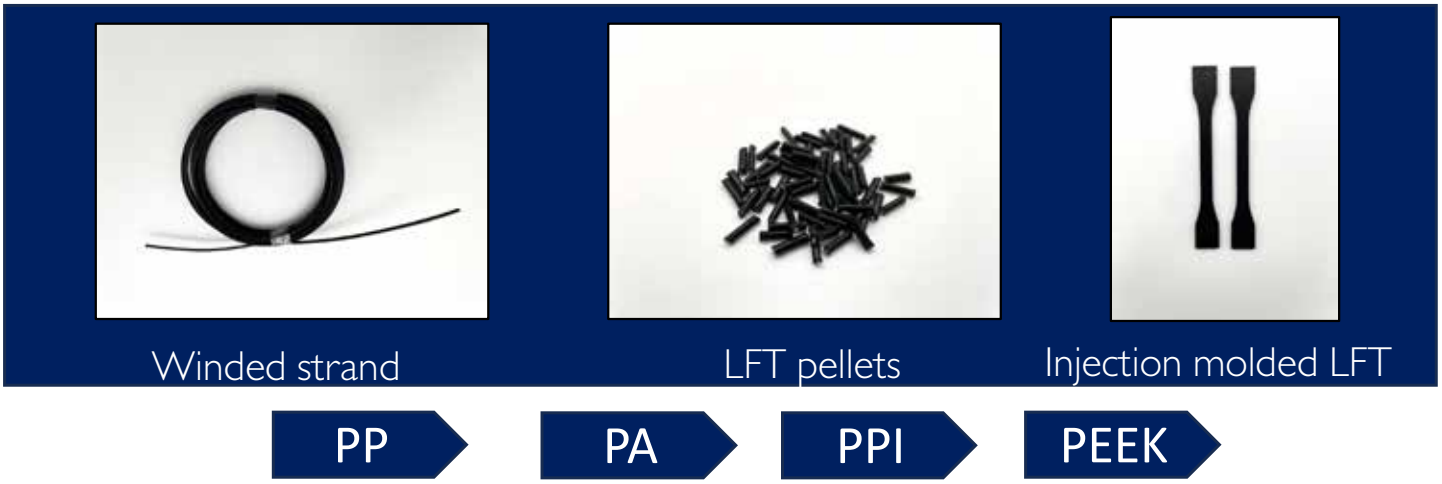
Figure 4. a.) Coating die attached to an Xplore MC 40 b.) spreaded fibers exiting the TOW impregnation die



Advantages of the micro-coating/impregnation line:

Feed your raw material with our automatic feeders and produce the LFT pellets in a few minutes.
The automatic feeders enable easy, accurate dosing and subsequently compounding.
The inlet and outlet diameters of the LFT coating die can be adjusted to customer needs.
As a result, you can coat different types and sizes of fibres in this system.
With the size of the outlet die, the coating thickness (percent) can be adjusted.

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