Meltblown: Less Clouds in the Simulation Sky

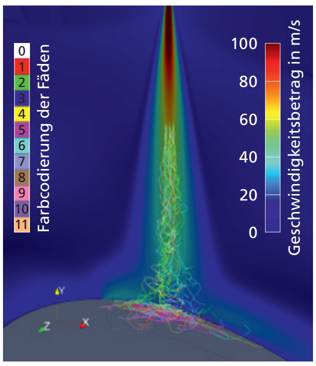
Nonwoven production is getting more attention than ever from the general public in Corona times, because nonwovens are crucial for infection control. Mouth guards, disposable bed linen, surgical gowns, wound protection pads and compresses are just a few examples. The ultra-fine nonwoven products are manufactured in so-called meltblown processes. ITWM simulations help to better understand the production processes and design them more efficiently. Researchers of the "Transport Processes" and "Flow and Material Simulation" departments provide support with their expertise.

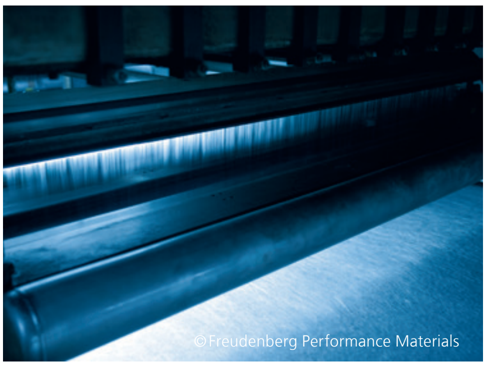
For example, in the Fraunhofer-internal project "ProQuIV", the entire production chain of infection protection is optimized in this way. The abbreviation stands for "Production and Quality Optimization of Nonwoven Infection Protection Clothing". This is because bottlenecks in the production of these materials were observed at the beginning of the crisis. For the class of meltblown nonwovens, increasing the efficiency of production is particularly difficult because these processes react very sensitively to fluctuations and material impurities.

Digital twin optimizes meltblown process

"Meltblown" is the name of the industrial production process whose ultra-fine fiber nonwovens are responsible for providing the crucial filter function in face masks. In this process, the molten polymer is forced through nozzles into a forward-flowing, high-speed stream. It is dispersed and cooled in a highly turbulent air flow. This is how the individual fibers (filaments) are formed. They swirl under the air flow, entangle and stretch, and fall more or less randomly onto a conveyor belt, where they solidify further as they cool.

In this process, a key factor is the behavior of the filaments in the turbulent, hot and fast air flow. The filaments' properties are affected by this air flow. "The complex process poses a great challenge in simulation," explains Dr. Walter Arne of Fraunhofer ITWM. He has been working at the institute for years on the simulation of various processes related to filaments, threads, and fibers. "This is because the quality of the filaments, and thus in the end of the nonwovens, is influenced by many factors. For example, by an aspect we call cloudiness." In the graphic on the right, it is clear what is meant by this: How homogeneous is the nonwoven? "Product quality can be greatly improved if non-uniformity is optimized. Our simulation helps with figuring out how to do that," the researcher adds.

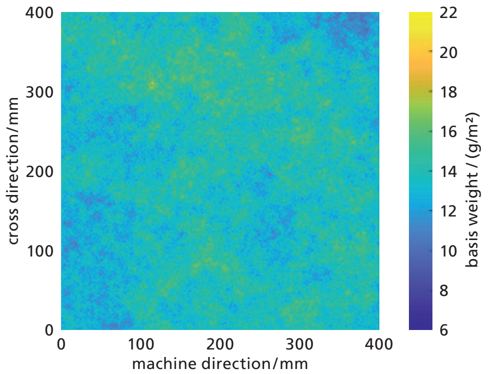




Left: Simulation of filaments in the meltblown production process. Right: Production of nonwovens using the meltblown process in Kaiserslautern.

Top: Quality control of a meltblown material in the clean room area. Bottom: Cloudiness: How homogeneous is the nonwoven? Simulated basis weight distribution as a measure of the homogeneity of the nonwoven.

This is where ITWM software comes into play. "With our Fiber Dynamics Simulation Tool FIDYST, the movements of the fibers, their stretching, their falling, and the orientation with which they land on a conveyor belt are predicted. Depending on the process settings, specific turbulence is created and thus nonwoven qualities that differ, for example, in structure, cloudiness, basis weight and strength," explains Arne.



Simulation across the entire process chain

Digital twins and calculations from Fraunhofer ITWM help to simulate and better understand the processes. The production of technical textiles thus not only becomes more efficient, but the nonwovens can be developed virtually without having to realize this in advance in a test facility. In this way, production capacities can be increased while maintaining quality. Simulations save experiments, allow new insights, enable systematic parameter variations and solve upscaling problems that can lead to bad investments in the transition from laboratory to industrial plant.

However, the virtual implementation of the meltblown process also opens up new opportunities for optimization at other levels: In the upscaling of industrially relevant processes, such as mask production, the ITWM expertise concerning filters is also used. The "Filtration and Separation" team headed by Dr. Ralf Kirsch has been working for many years on the mathematical modeling and simulation of various filters.

More information, including simulation video, at www.itwm.fraunhofer.de/meltblown-process-simulation

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