

# NANOFIBER MEMBRANE START-UP

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**Abstract:** In 2004 Prof. Oldrich Jirsak from the Technical University of Liberec developed a machine for the industrial production of a nanofiber layer. Because of this equipment, new nanofiber layer oriented projects started to occur. One of such projects in recent years was a nanofiber membrane for use in sport and outdoor activities and also in the army. This project was a cooperation between the Technical University of Liberec and a Czech investor which led to the creation of a new company called NANOMEMBRANE. The result of their work is not only clothing with a nanofiber membrane, but also further cooperation between the private sector and a state university.

**KEY WORDS:** NANOFIBER MEMBRANE, START-UP, STATE UNIVERSITY, PRODUCT

## 1. Introduction

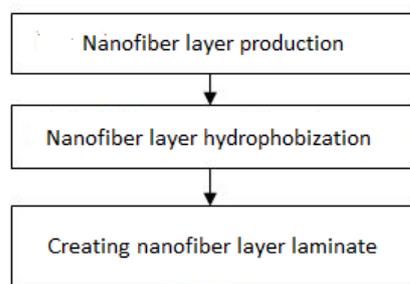
If you look up the term "start-up" on Wikipedia, you will see that there is not one unified/ universal definition, but that there are several of them. The one which best summarizes our project is the following one: "A start-up is usually a business plan at least in the stage of an idea which has the potential to be turned into a money making business model and which is trying to meet a market or business need in an innovative way. A start-up can be any new company, mostly technological, which is solving problems in a locally or timely innovative way."

The first part of this article describes the development and production of a nanofiber membrane in our project and the second part shows how this project was turned into a new company called NANOMEMBRANE [1].

## 2. The development and production of a nanofiber membrane

Nanofibers can be called the material of the future. They can bring revolutionary changes in the fields of electronics, medicine, the car industry, filtration processes, ecology, nanocomposites, IT, personal protective equipment, clothing and many more applications.

Nanofibers are various polymer fibers of a diameter up to 500 nm. They are made by electrospinning and then processed into so far only nonwoven textiles. In 2004 the Technical University of Liberec patented a spinning machine called Nanospider [2]. This machine enabled the industrial production of a nanofiber layer and so started many research projects whose aim was to find new nanofiber based products. One of these products is our nanofiber membrane. Picture 1 shows the production of a nanofiber membrane.

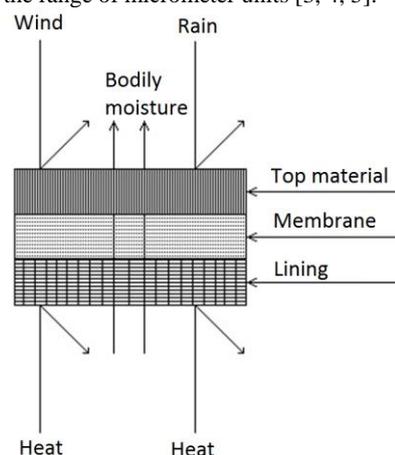


Pic. 1 production of a nanofiber membrane

## 3. Membrane for use in the clothing industry

In Pic. 2 you can see how such a nanofiber membrane for clothing works. Drops of water (snow, rain) fall on the top surface material. The top material tries to stop these drops from getting under this textile. This top material is often impregnated or has some chemical finish to achieve this, but at the same time it must be able to let water vapour through. This top material with its good properties has also got its limits and that's why a nanofiber membrane is added. The different materials (woven or knitted textile and nanofiber membrane) are laminated together to form 2-layer, 2.5-layer or 3-

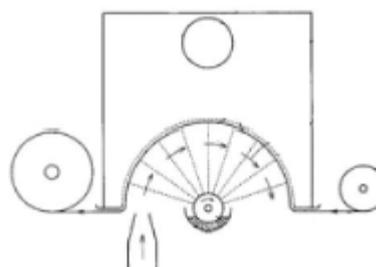
layer laminates. The membranes are made of polymers, the most common ones being PTFE (Polytetrafluoroethylene), PES (Polyethersulfone) or PUR (Polyurethane). The membrane thickness is in the range of micrometer units [3, 4, 5].



Pic. 2 The membrane function diagram

## 4. Nanofiber membrane development

A Nanospider machine was used to produce the nanofiber membrane (Pic.3). Polyurethan polymer was chosen because it is easy to use on a Nanospider machine, but also for its elasticity as it gives a final laminate tensibility that is very desirable in some kinds of closing.

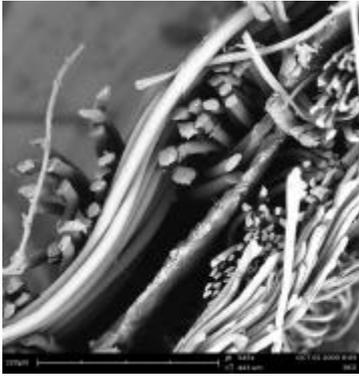


Pic. 3: The Nanospider machine for the production of nanofibers by electrospinning [6]

The produced nanomembrane is made hydrophobic using Fluorcarbon type C6 monomer in low vacuum plasma to achieve a higher hydrostatic resistance. The hydrostatic resistance can be more than 20 000 mm depending on the top material laminated to the membrane.

After hydrophobization the nanomembrane is laminated together with other textile materials.

Many long-term tests have shown that a 3-layer laminate is the only solution for nanofiber layers as these layers are very susceptible to friction and for that reason must be well protected on both their sides by other textile materials laminated onto them. Pic. 4 shows such a 3-layer laminate.



Pic. 4 - 3-layer laminate cross-section

## 5. Startup: Technical University of Liberec and the Svitap company

The development of a nanofiber membrane started in 2009 when it was the topic of a final thesis under the supervision of the above-mentioned Prof. Oldrich Jirsak. The work continued in a postgraduate doctorate course and by the end of 2013 the nanofiber membrane development was complete, at least on laboratory equipment. At this stage an investor was sought out – a Czech company called Svitap J.H.J. which runs a technical textile business and has about 500 employees. The Technical University of Liberec and Svitap J.H.J. signed a contract about their cooperation. In this period of time a number of utility models and patents were registered. In 2015 a company called NANOMEMBRANE was created which started the production and sale of nanofiber membranes. The nanofiber membrane on its own won several significant awards. In 2017 the company's product range expanded, new product lines were added. Sports and outdoor clothing were

joined by a fashion line (laminates with natural textiles) and the membrane was also used in footwear production.

The NANOMEMBRANE company has its headquarters in Svitavy (a town between the cities of Prague and Brno) and employs 8 people. There are 4 owners of NANOMEMBRANE, one of which is the above mentioned Svitap J.H.J. company. Today, NANOMEMBRANE successfully sells its products (not all of them nanomembrane-based) but also closely cooperates with the state university. It has been the university's goal to find an investor who would be able to get the project from the development stage to production while at the same time would be interested in cooperation on new development projects, as it often can be seen in Western Europe and the USA.

## 6. Literature

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