EXPERTISE AT UGENT

ELECTRO SPINNING

UNIVERSITEIT GENT

OUR OFFER

ELECTROSPINNING

During electrospinning a polymer solution is pumped through a hollow needle with a certain flow rate in an electric field. When the electrostatic forces of the solution overcome the surface tension, the droplet at the outlet of the needle deforms into a Taylor cone. From this moment a jet stream is drawn out of this Taylor cone. Because of the interaction of the charges inherent to the solution and the external electric field, this jet is subjected to bending and splaying. As a result, fine fibres are randomly deposited onto the collector plate, and a nonwoven structure is formed.

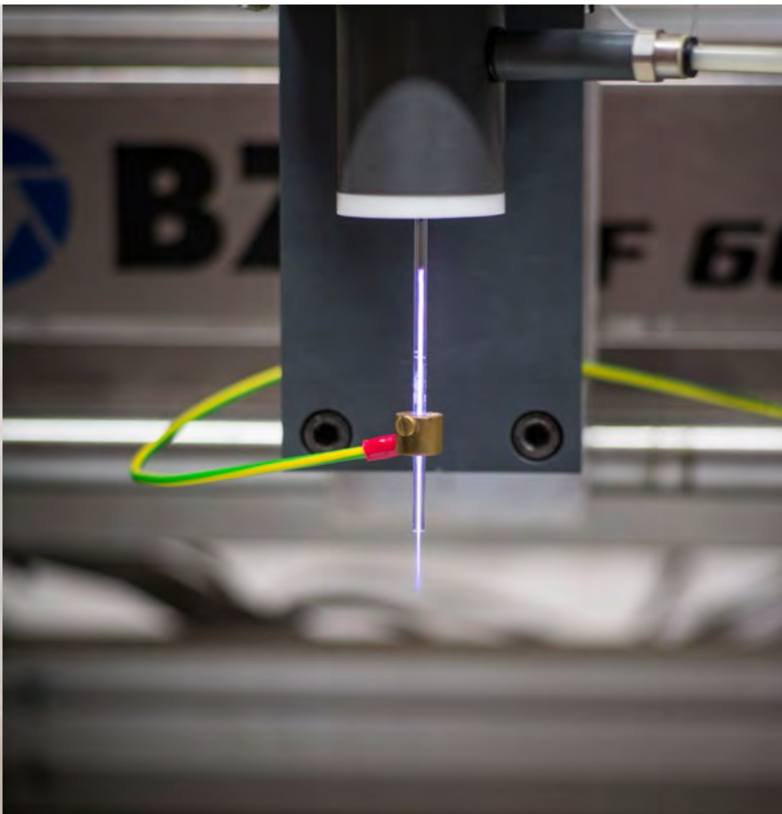
PROPERTIES

By reducing the fibre diameter to less than 500 nm, several specific and unique characteristics appear. In contrast with macroscale nonwovens, these nanoscale structures have a larger specific surface to volume ratio (up to 100 m^2/g), a higher porosity (up to 90%) and a smaller pore size (50 to 200 nm). Since the roughness of nanofibre mats is determined on the nanolevel, they have a very flat surface. Also the mechanical performance may be superior to other forms of the same material. Because of the large specific surface area these structures absorb fluids very efficiently. Other important properties are the malleability and the ease of fibre modification.

FROM MATERIAL SELECTION TO APPLICATION

We offer our expertise and knowhow to help you from material selection till pilot scale production. After careful selection of the materials (including the solvent system), fibres are electrospun using mono- and multinozzle as well as coaxial lab equipment. For future upscaling it is important to focus on producing fibres with controlled diameter and volume density.

Depending on the application functionalization of the electrospun fabric will be necessary. Finally our pilot installation can be used to produce the desired quantities for application testing.



OUR OFFER

MATERIAL SELECTION

LAB SCALE ELECTRO SPINNING

FIBRE FUNCTION-ALIZATION

FROM LAB TO APPLICATION

OUR TOOLBOX

To support the R&D process UGent offers a wide range of tools to facilitate materials development and selection

(A) ANALYTICAL EQUIPMENT

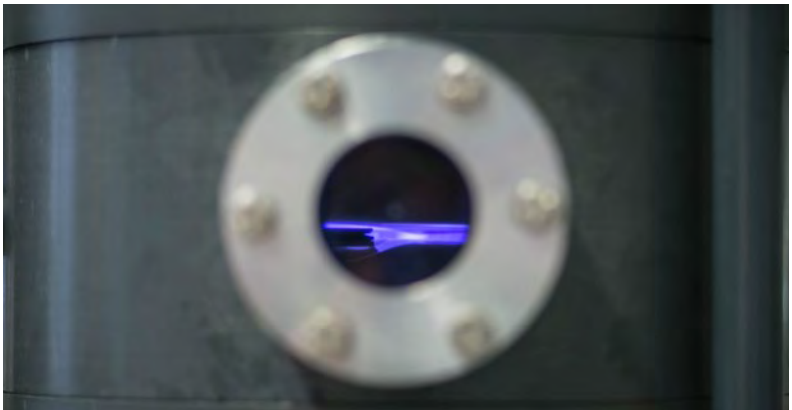
We offer polymer and fibre analysis, resulting in information on every step of the electrospinning process; virgin polymers used for electrospinning, electrospinning solutions, nanofibrous membranes and end products such as nanofibre-containing composites. Our researchers have following advanced characterization infrastructure at their disposal:

- **Molecular characterization:** Structural elucidation using NMR, MALDI-TOF, on-line IR, ...
- **Polymer structure characterization:** Determination of molecular weights and molecular weight distributions by size-exclusion chromatography (range of eluents and detectors).
- **Electrospinning solution characterization** by conductivity, surface tension, turbidimetry, dynamic and static light scattering, particle size measurements, viscosimetry,...
- **Surface visualization and characterization:** Measurement of microscopic features and microstructures to nano-scale dimensions using optical microscopy, SEM, TEM, AFM, IR mapping, XRD, XPS, ... Surface wettability using static and dynamic contact angle measurements. Surface interactions through quartz crystal microbalance-coupled ellipsometry. FT-IR, UV and visible spectrophotometry.
- **Absorption and Desorption behaviour**: Dynamic vapour sorption (DVS) offers the possibility of analysing moisture content and absorption/ desorption isotherms of a wide range of polymer products and fibres.
- **Thermal and mechanical analysis:** Thermal behavior can be studied with differential scanning calorimetry and thermogravimetry; the mechanical behavior by dynamic mechanical analysis, rheology and materials testing equipment (TGA, DSC, mDSC, DMA, ...).

(B) LAB SCALE ELECTROSPINNING EQUIPMENT

All the electrospinning equipment is based on nozzle solvent electrospinning, meaning that a polymer solution is brought into the electric field using a needle. Additionally, also ceramic systems based on sol-gel technology and blend polymer solutions can be electrospun.

- **Mononozzle:** Several setups are available, offering choices in needle configuration, collectors and environment. For the mononozzle setups, using only one needle, both a conventional collector and a rotating drum collector are present, offering the possibility to produce the classic randomly oriented nanofibrous nonwovens and highly aligned nanofibrous structures. Both ribbons and A4-sized samples are possible. Additionally to a classic needle in different gauges, also a heated needle-based system and a **coaxial needle system** are available. The latter can be used for the production of both single polymer nanofibres and core-shell structures.



- **Multinozzle:** The lab multinozzle technology is based on the use of up to 15 needles for the production of larger scale samples, typically of about 0.5x2 m. Sample thickness and uniformity are controlled. Both stand-alone structures and nanofibrous coatings are produced using this lab-scale technology. Also a rotating drum collector can be equipped with a multiple independent nozzle system, making the production of composite / comingled nanofibrous webs with two (or more) components possible.

Multiple independent nozzle system makes it possible to produce composite / comingled nanofibrous webs with two (or more) different polymer types.

(C) FIBRE FUNCTIONALISATION

We have experience with a wide range of functionalization strategies.

- **In situ functionalization (functionalization during the electrospinning process):** Extensive experience of functionalization through doping of the electrospinning solution, using e.g. dyes, nanoparticles, biocides... Functionalization through the co-electrospinning of functionalized polymers.
- **Post functionalization (functionalization after electrospinning):** Coating of the nanofibres, including sol-gel and metallic. Plasma activation or polymerization in order to graft or coat the surface.

All functionalization strategies aim to exploit the high specific surface area of the nanofibre membranes.

(D) FROM LAB TO APPLICATION

UGent is offering a pilot line for the continuous large scale production of nanofibrous webs. Our pilot line produces fabrics with a width of up to 1 m. Up to 300 nozzles are available to allow fast production (up to 60 m^2/hour). The system has the flexibility to coat fabrics by direct electrospinning (e.g. glass fibres, nylon, ...)

OUR EXPERT TEAM

PROF. DR. IR. KAREN DE CLERCK
Fibre and Colouration Technology

PROF. DR. PETER DUBRUEL
Polymer Chemistry & Biomaterials group

PROF. DR. IR. NATHALIE DE GEYTER
Research Unit Plasma Technology

Fibre and Colouration Technology Research Group The Fibre and Colouration Technology Research Group is headed by Karen De Clerck and is embedded within the Faculty of Engineering and Architecture, Department of Textiles. It deals with various aspects of fibrous materials with key areas such as fibre production and processing for advanced applications as well as smart textile materials. An important share of the activities are concentrated on the electrospinning process and the characterization as well as the application of the resultant nanofibre based materials. Focus is given to understanding and controlling the electrospinning process with a variation of available production set-ups allowing for both small-scale studies as well as pilot-scale production. The nanofibre materials are studied with a wide range of advanced analytical techniques and are explored towards end-applications. The functionalization of the nanofibre materials during or post electrospinning is within the groups interest as well. The application driven research activities such as nanofibre membranes for liquid filtration, nanofibre toughened composite applications, polymer blend and functionalized nanofibre materials for biomedical applications are based on strong research collaborations within the UGent consortia allowing for an overall approach.

Polymer Chemistry & Biomaterials group (PBM)
The Polymer Chemistry and Biomaterials research group is specialised in functional polymers for biomedical applications, biomaterials (e.g. biocompatible coatings), advanced drug/gene delivery systems, scaffolds for tissue engineering, biosensors and polymers for optical applications. The PBM group owns state-of-the-art equipment for polymer synthesis, surface modification and material characterization. In addition, rapid prototyping techniques such as 3D printing and electrospinning are part of the PBM expertise. The research topics vary from tissue engineering (cardiovascular grafts, liver and skin regeneration), drug delivery and wound dressings to cleaning of optical fibers.

Research Unit Plasma Technology (RUPT)
The research unit Plasma Technology focuses on the physics and applications of non-thermal or “cold” plasmas. Next to the development of innovative plasma sources for environmental, surface engineering and biomedical applications, part of the research involves fundamental studies on underwater plasmas, plasma-surface interactions and microplasmas. Atmospheric pressure plasma technology is utilized to create advanced biodegradable electrospun mats. Plasmas are used for the treatment of pre-electrospinning polymer solutions and for the surface modication of electrospun mats.

CONTACT INFORMATION

The Electrospinning cluster is supported by
the business units **ChemTech** and **Composites @ UGent**
aiming to be the local point for **industrial collaborations**.

The business units facilitate and coordinate
a set of **industrial projects** and manage
a **strategic IP portfolio** and its licensing opportunities.

The business developers of ChemTech and Composites @ UGent are at your disposal

DR. AN VAN DEN BULCKE
ChemTech Technologies
for Life Science

Krijgslaan 281, S4
B–9000 Gent – Belgium
A.Vandenbulcke@UGent.be
www.chemtech.ugent.be
T +32 9 264 44 62
M +32 474 81 23 81

DR. IR. ILSE CHRISTIAENS
Composites @ UGent

Technologiepark 903
B-9052 Zwijnaarde – Belgium
Ilse.Christiaens@UGent.be
www.compositesconsortium.ugent.be
T +32 9 331 04 19
M +32 487 46 97 78

DR. BART HOMMEZ
ChemTech Technologies for
Material and Chemical Industries

Krijgslaan 281, S4
B–9000 Gent – Belgium
Bart.Hommez@UGent.be
www.chemtech.ugent.be
T +32 9 264 96 03
M +32 471 99 41 94

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