The European Technology Assessment Conference:

„Technology Assessment and Policy Areas of Great Transitions“

Clean Water – Energy for our everyday Life

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- Global Megatrends Drive Innovations
- Importance of Clean Water for our society
- Membrane Technology for Clean Water
- Electrospun nonwovens for microfiltration
- Assessment of the opportunities of the presented technology
- Global Outlook
  - Urban Water Management in Germany
  - International Transferability
- Summary

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Global Megatrends Drive Innovations

Health & Quality of Life

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Construction & Housing

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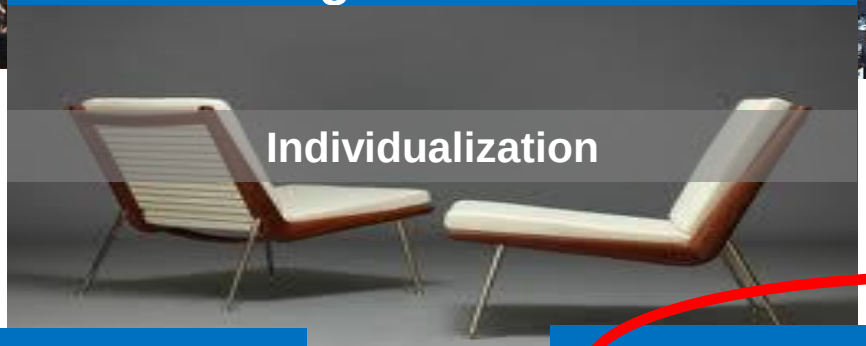
Design & Comfort



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Mobility & Communication

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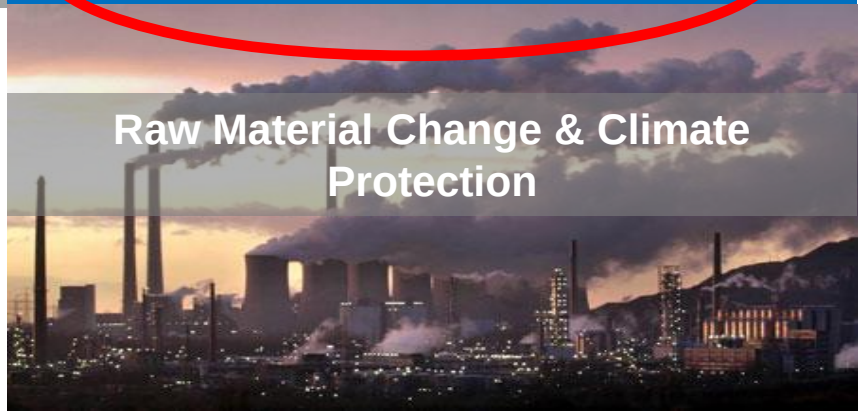
Energy & Resources



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Shortage of drinking water in the world

- UNESCO: Currently 900 Mio. people without clean drinking water
- UN: Until 2070 a lack of drinking water even in Europe
- Over 900 million people have no access to clean water

Factors of influence for the quality of drinking water in Europe

- Growing economy and rising urbanization
- Increasing consumption of water
- Use of groundwater tripled over the last 50 years
- Pharmaceutical products in waste water
- On an average every German citizen got 10 packages of medicine in 2010

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State of the art in waste water management

- Sedimentation tanks
  - State of the art of waste water management
- Membrane technology
  - The water is cleaner than the output of sedimentation tanks
  - High investment costs (70 -150 €/m²) and cost of operation
  - 50% of the energy is needed for cleaning the membrane

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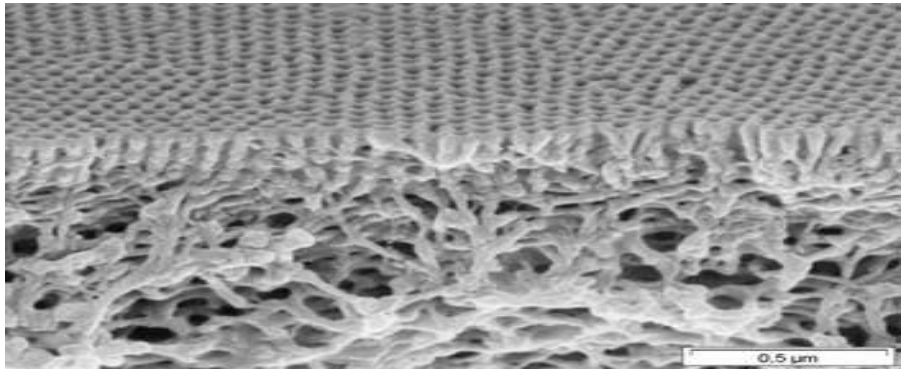
Comparison nonwoven and membrane

Membrane	Nonwoven
Expensive production process through the use of solvents and need of several process steps	One-step-process: Molten polymer is spun directly into a nonwoven structure
Difficult to clean because of the symmetrical structure	The asymmetrical composite structure prevents the ingress of particles into the structure
Pore size dependent on chemical and mechanical processes	Pore size dependent on fiber diameter



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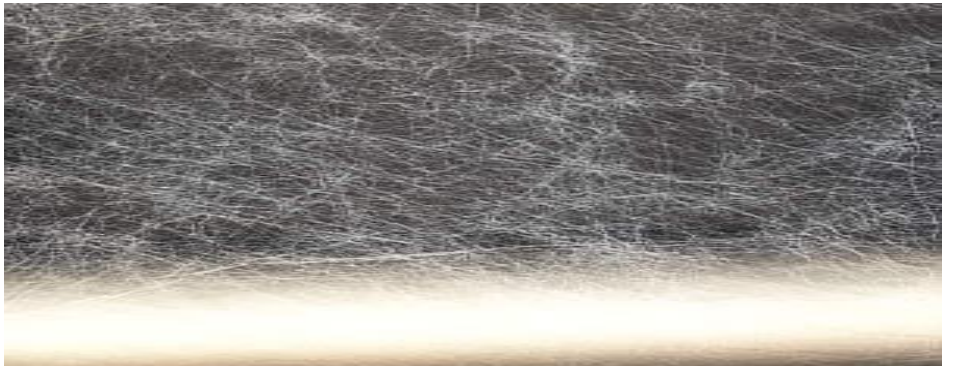

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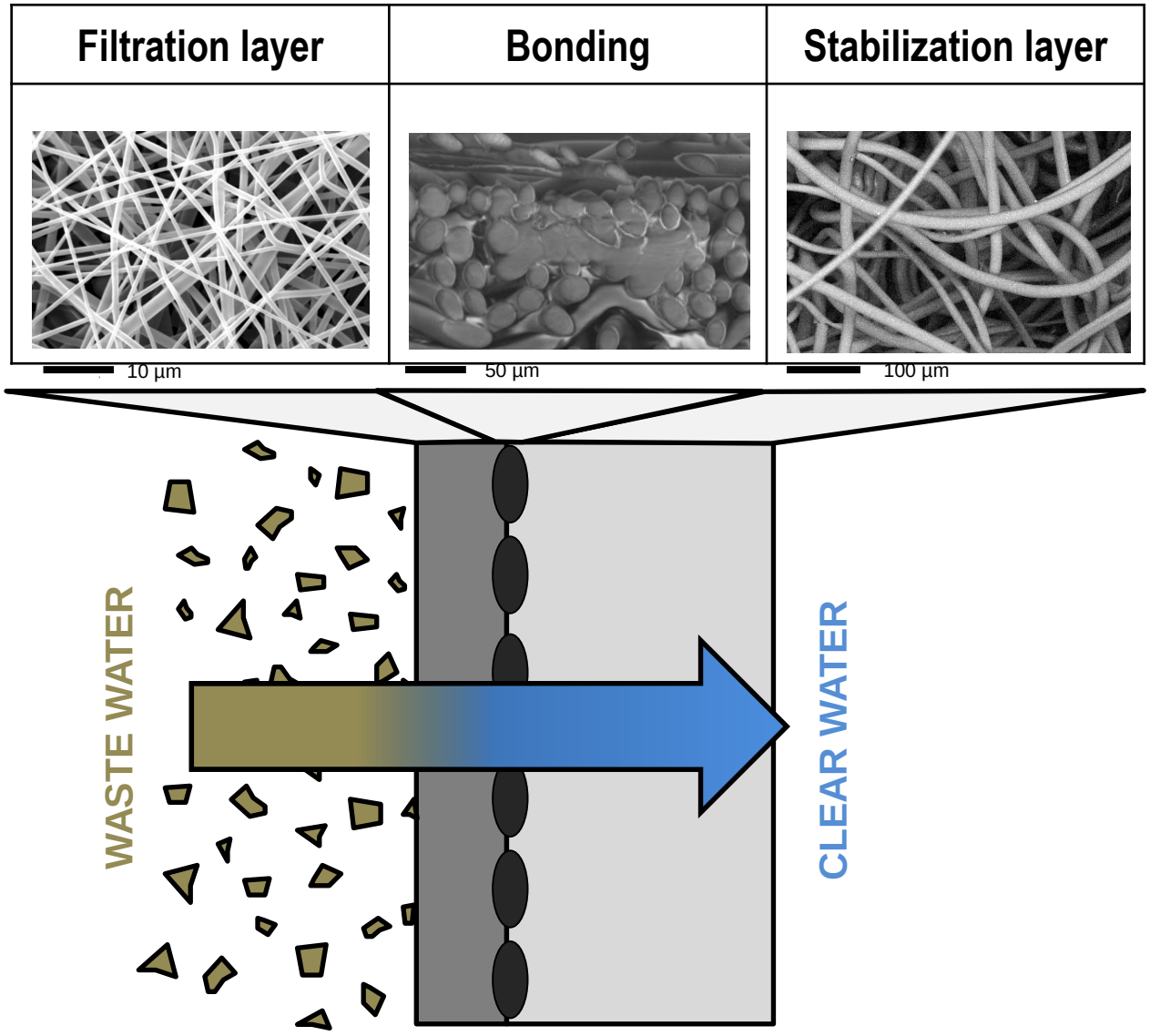
Composite Structure

- Composite structure
- Two layers
  - One for filtration
  - One for stabilization
- Bonding of both layers

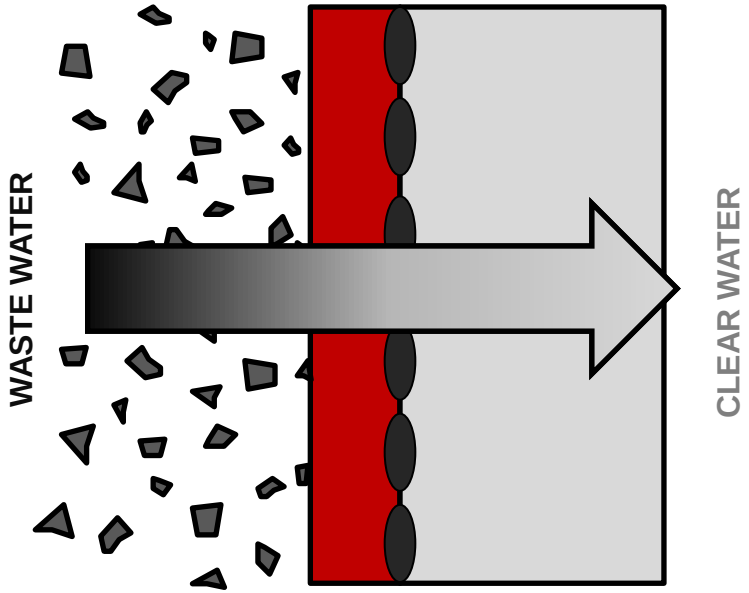


Filtration layer

- Function
  - Separation of the particles
- Properties
  - Pore size < 1 µm

    → Fiber diameter < 500 nm
  - Low pressure drop

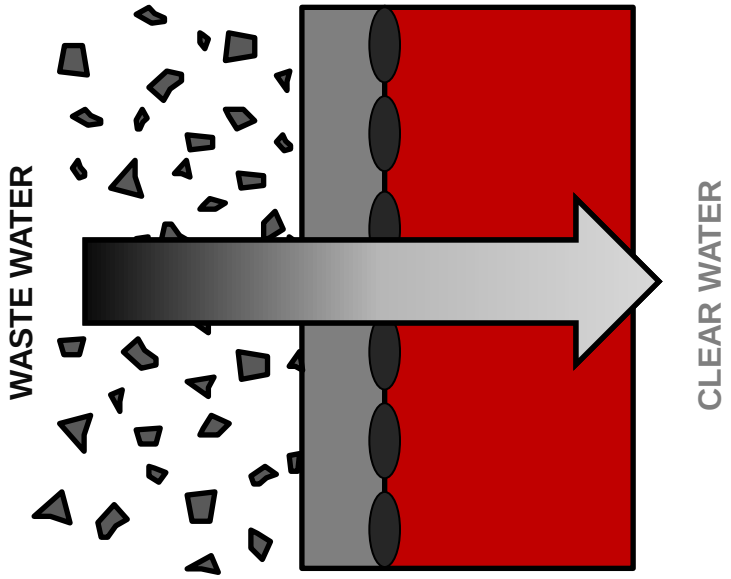
    → Thin layer



- Electrospun nonwovens from molten polymer

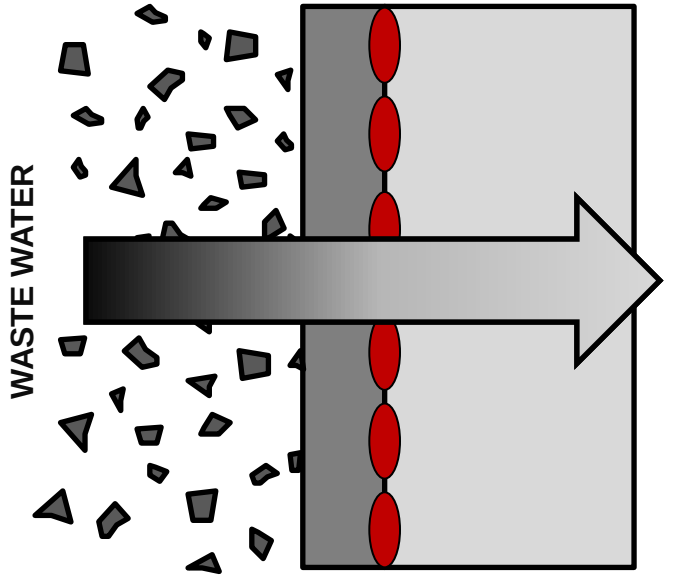
Stabilization layer

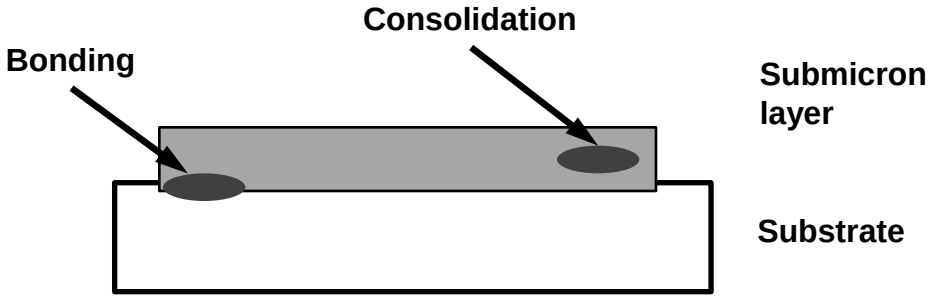
- Function
  - Stabilization of the electrospun fibers
- Properties
  - Low pressure drop
  - High strength
  - Low price
- Spunbond



Bonding

- Function
  - Bonding of the filtration layer and stabilization layer
- Properties
  - No fiber damage
  - Consolidation within the electrospun fibers
  - Bonding onto the stabilization layer





Schematic of bonding and consolidation

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Opportunities for elektrospun nonwovens

- Reduced production and operating costs (abstinence of expensive and complicated to recycle solvents, compact design)
- Reduction of process steps
- Better waterquality by slowed pollution of Membransubstituts
- innovative leap with beneficial effects for humans and the environment

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Global Outlook - Urban Water Management in Germany

- The development of membrane technology continues
- Low prices for non-woven fabrics will help to reduce water and sewage costs for the population
- It offers the opportunity to secure water resources for the future

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Global Outlook – International Transferbility

- Application of membrane processes in wastewater treatment will increase worldwide by 15% and in the treatment of drinking water by about 20 %.

- This process can do its part to reduce the worldwide water problem and to help the majority of the world's population.

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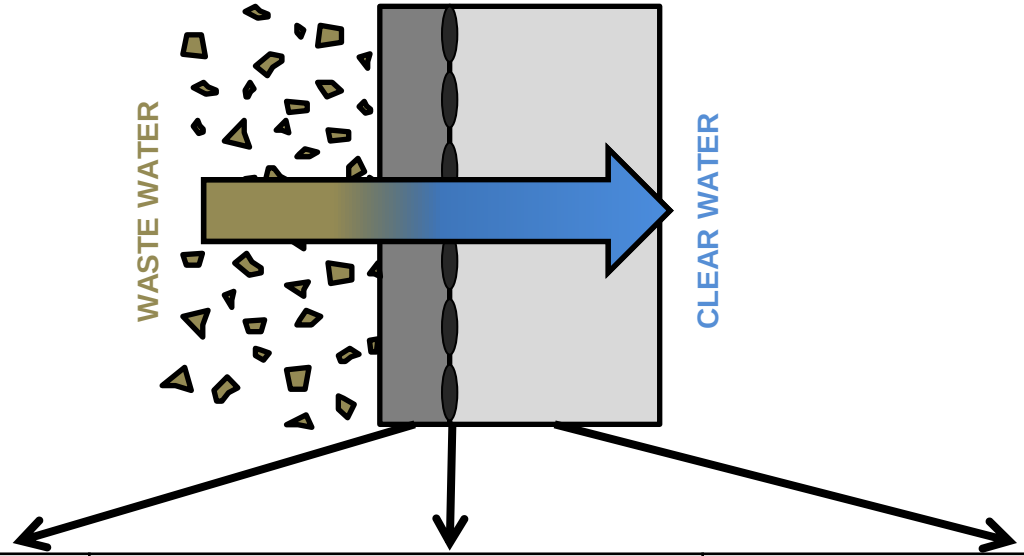
Summary

- New technologies for the waste water management are necessary
- Nonwovens are promising for the use in liquid filtration



Filtration layer	Bonding	Stabilization layer
Electrospinning	Laser welding and electrospraying of the absorber	Spunbond
Spinning of submircon fibers (<500 nm diameter) und upscaling of the process	Spraying of small particles (<2µm), upscaling of the process and targeted heat input	Nonwoven with high strength and a low pressure drop

Summary

Nonwoven composites have a high potential for waste water management!

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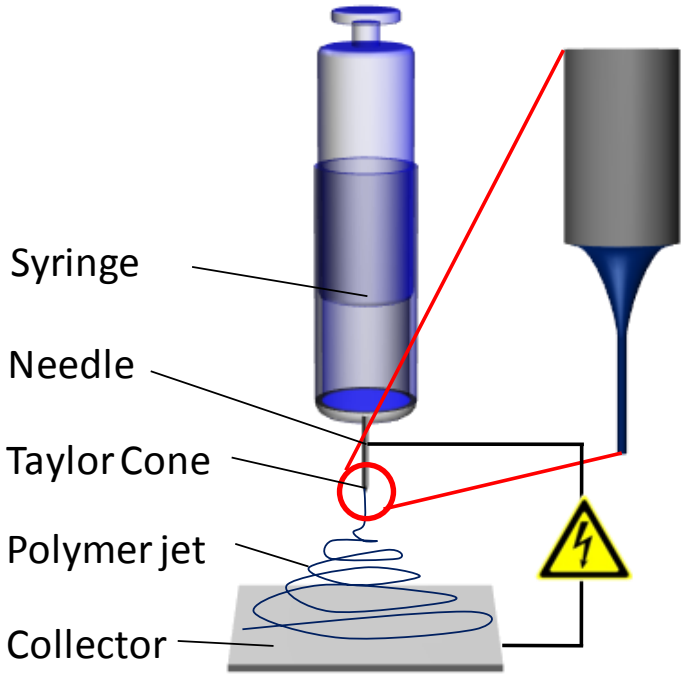
Principle of melt electrospinning

- Molten polymer in a syringe
- Application of an electric field between the needle and a collector electrode
- Forces on the melt form a Taylor cone and pull a jet out of the polymer
- After a stable region the polymer jet becomes unstable (whipping motion)



Electrospinning schematic

Principle of the bonding technology

- Laser welding for thermal bonding
  - Polypropylen is permeable for laser light
- Application of the absorber via electrospraying
  - Small particles of less than 3µm
  - Targeted and local heat implementation
  - Preservation of the fiber structure after the welding