

# Roll-to-Roll Fabrication of Biomimetic Surfaces

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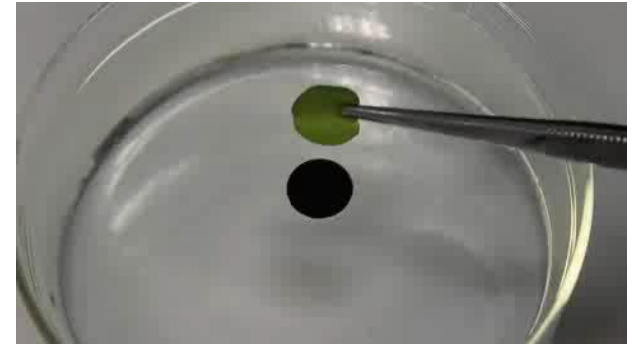
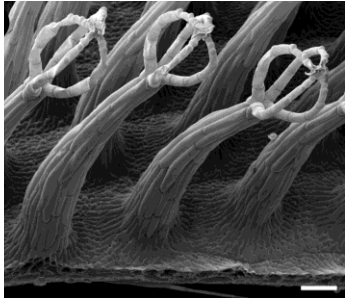




# Example 1: *Salvinia Molesta*

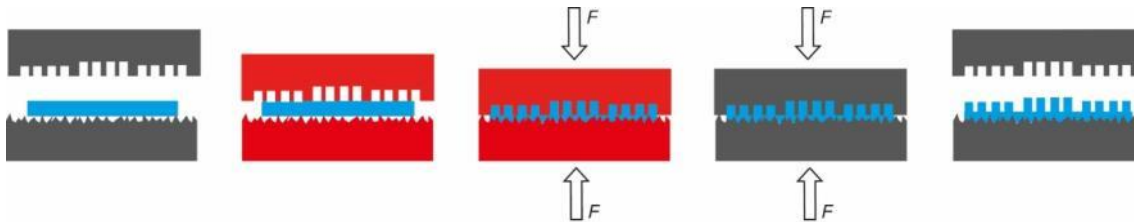
## ■ Water fern *Salvinia molesta*

- Hydrophobicity → Superhydrophobic surfaces
- Air retention under water → Drag reduction
- Oleophilic → Oil spill cleanup



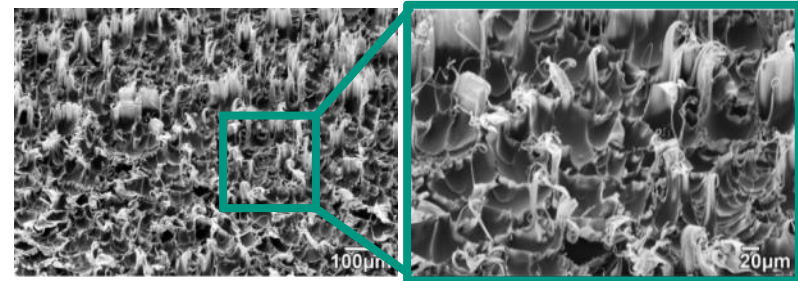
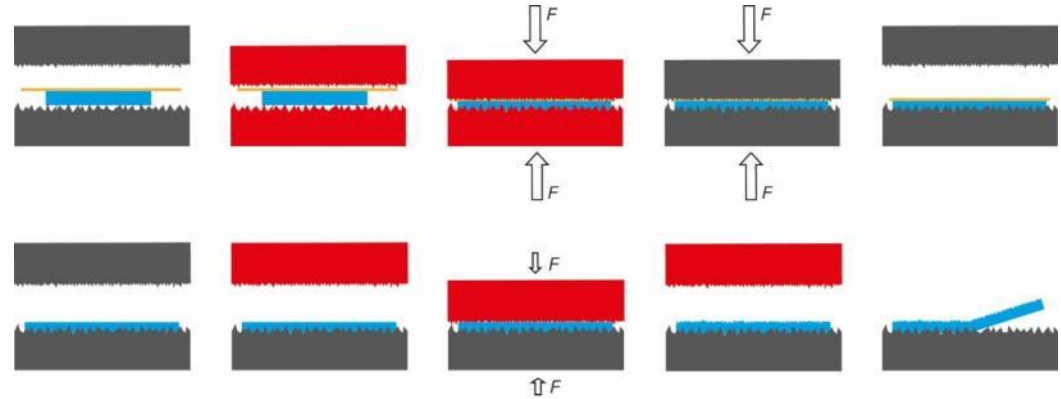
# How to obtain such Surfaces in general?

- Structuring through a nickel master
- Hot embossing into polymers
- Sub- $\mu\text{m}$  precision



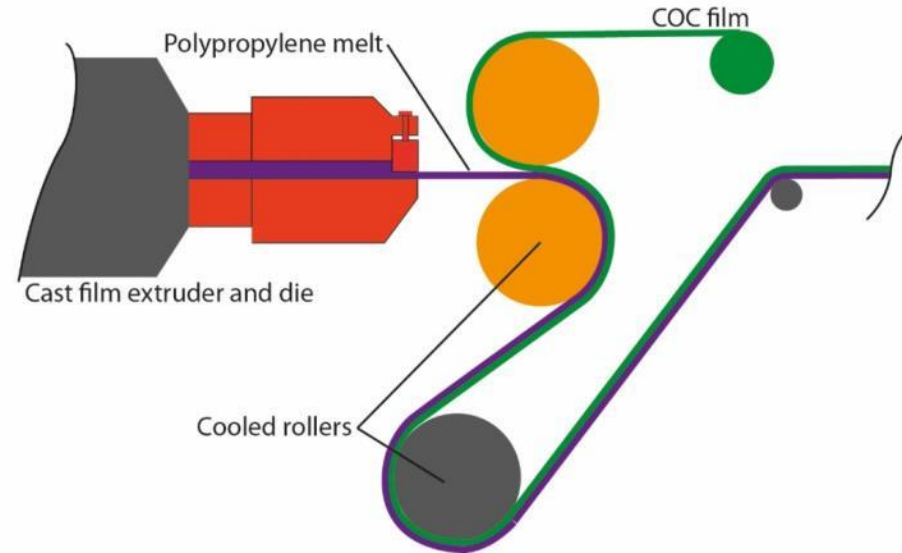
# Hot Pulling

- Sandblasted steel “mold”
- 2 steps: fixing and pulling
- Problems:
  - Limitation in area
  - Long cycle times
  - → Low productivity
  - → Limited applications



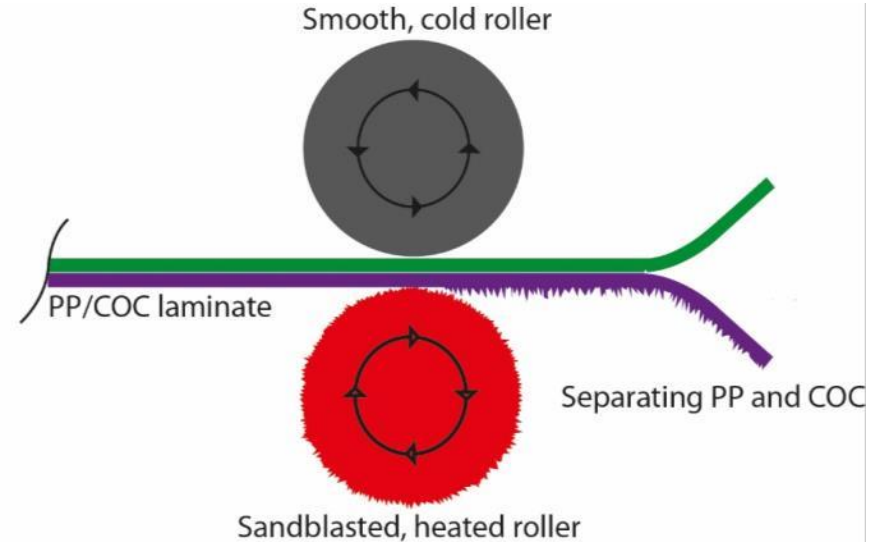
# R2R Hot Pulling: Step 1 – Support Layer

- Extrusion machine with sheet nozzle
- Co-extrusion of polymers
- PP and COC adhere but do not mix
- COC acts as support layer



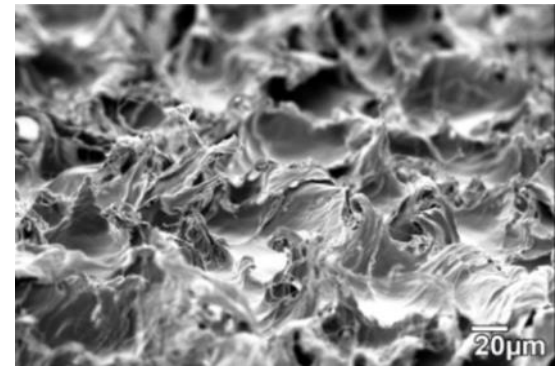
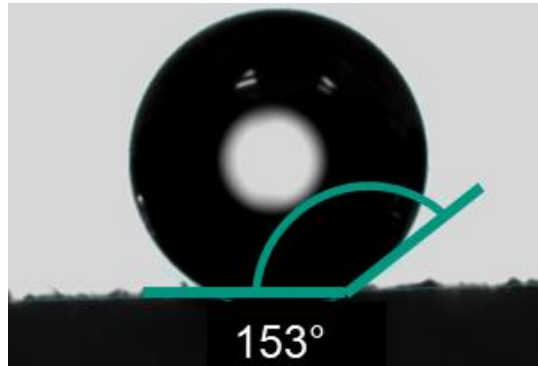
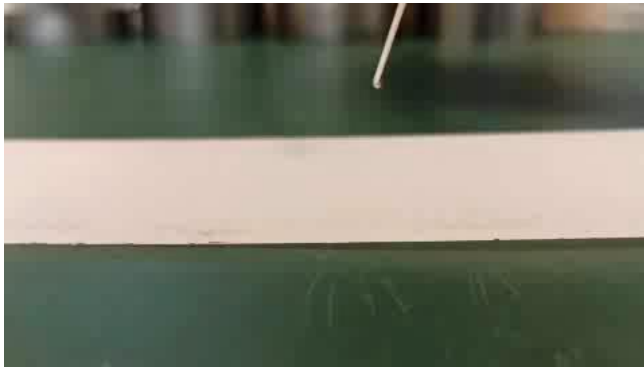
# R2R Hot Pulling: 2<sup>nd</sup> Step – Hot Pulling

- R2R hot pulling
- $T_{melt}(COC) > T_{melt}(PP)$
- PP and COC can be separated
- Important parameters:
  - Sandblasted roller
  - Maximum gap size
  - Roller just around  $T_{melt}$



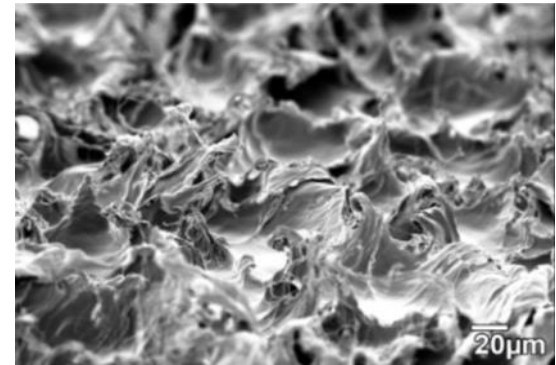
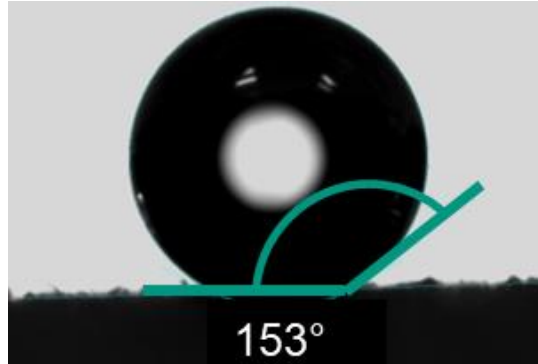
# Functionality of Nanofur

- Fur-like surface → Nanofur
- Square meters covered with nanofur
- Contact angle  $>150^\circ$



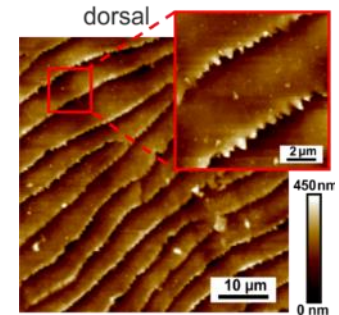
# Functionality of Nanofur

- Fur-like surface → Nanofur
- Square meters covered in nanofur
- Contact angle  $>150^\circ$
- Excellent oil water separation



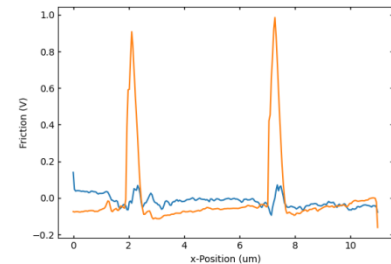
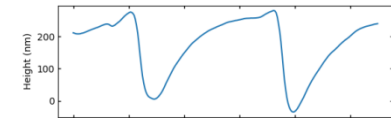
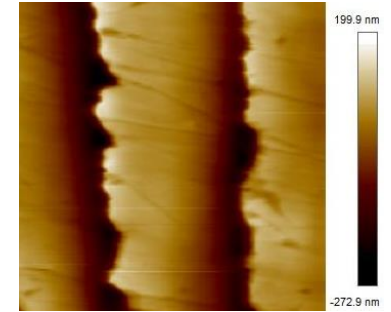
## Example 2: Sandfish (*Scincus scincus*)

- „Swims“ through sand
- Step structures on scales
- Step height: 200 nm
- Periodicity:  $\sim 6 \mu\text{m}$



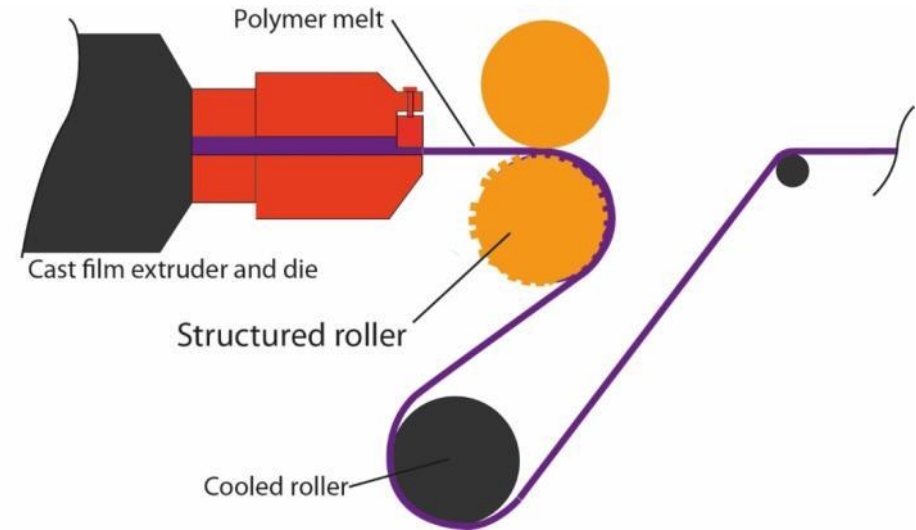
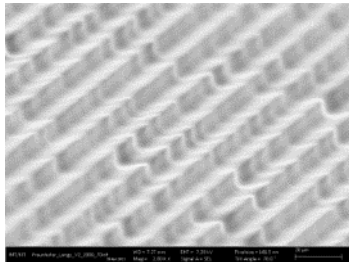
# Application of Sandfish Structure

- Sandfish-Structure creates anisotropic friction
- Particle transport trough vibration
- Application: Cleaning solar panels
- Losses trough soiling: up to 80%



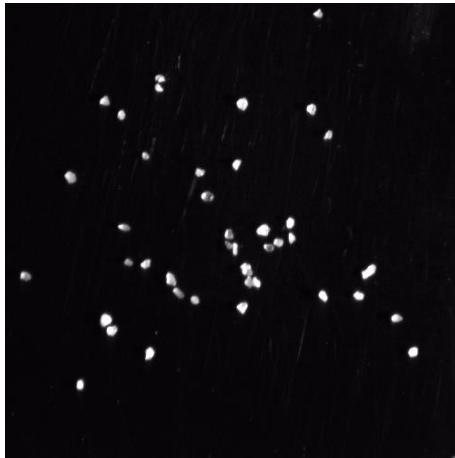
# R2R Hot Embossing

- Film extrusion
- Roll imprinting in polymer melt
- Advantages:
  - Polymer melt
  - Long mold filling time
  - Holding pressure
  - Cooling in mold

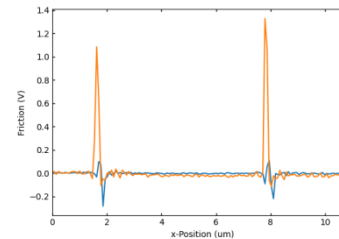
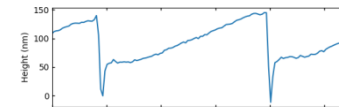
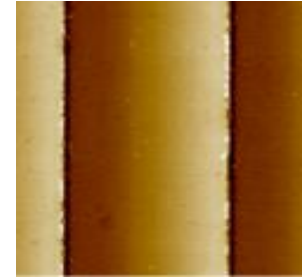


# Functionality of Sandfish Surfaces

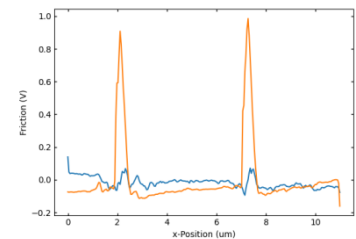
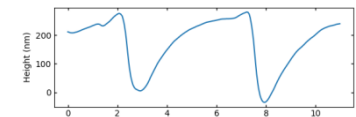
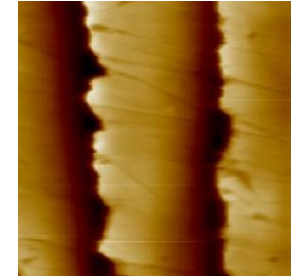
- Anisotropic friction
- Vibration stage with particle tracking
- Sufficient cleaning of surface



Artificial surface



Sandfish

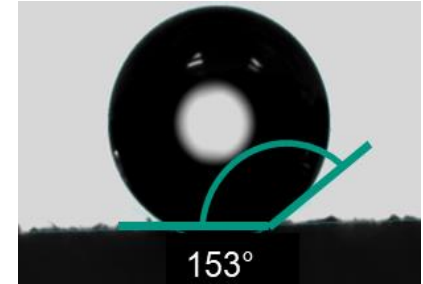
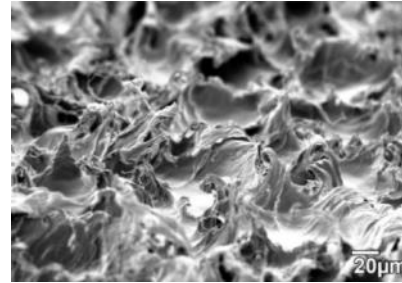


# Conclusion

- Roll to roll imprinting for biomimetic surfaces

- Nanofur:

- Excellent properties
- Large structured area
- Industrial partners needed



- Sandfish structures

- Optimal geometry
- Optimal excitement
- Field test

