Solvent-Thermal Induced Roughening: a Novel and Versatile Method to Prepare Superhydrophobic Membranes

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Abstract: Surface roughness enhancement by fabrication of multi-scale nano/microstructure is an effective strategy to prepare superhydrophobic membranes. In this study, we report for the first time a novel solvent-thermal induced roughening (STIR) method to increase surface roughness on various membrane surfaces for enhanced hydrophobicity. The STIR involves the swelling of a polymer surface to create a soft shell/hard core structure under the combined action of solvent and heating, followed by a controllable surface roughening as a result of mismatched thermal expansion between the shell and the core. A polyvinylidene fluoride (PVDF) nanofibrous membrane was treated by this method. Densely-packed nanofins were formed on the nanofiber, leading to a significant increase of average roughness from 3 nm to 28 nm. The treated membrane, with an enhanced hydrophobicity (from 132.8° to 155.2°) and surface area (from 7.3 to 19.0 m\textsuperscript{2}/g), showed superior anti-wetting performance to the low surface tension feed water than the pristine membrane in a membrane distillation process. We further demonstrate the versatility of the STIR method by increasing surface roughness on various forms of polymeric substrates.
The novel solvent-thermal strategy reported here opens up new directions to fabricate superhydrophobic surfaces and membranes, which can greatly benefit a wide range of applications such as membrane distillation, oil/water separation, membrane absorption and membrane catalysis.

**Keywords:** surface roughness enhancement, solvent-thermal treatment, superhydrophobic membrane, polyvinylidene fluoride, membrane distillation

**Solvent-Thermal Induced Roughening (STIR)**

![Diagram of the STIR process](image)

1. Pristine membrane
2. Solvent-thermal treatment
3. Treated membrane

- Solvent-induced surface swelling
- Thermal-induced surface roughening
- Soft-shell/Hard-core structure