Self-cleaning Properties of Nanostructured Polypropylene Foils Fabricated by Roll-to-Roll Extrusion Coating

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Technologies based on superhydrophobic treatments of artificial surfaces are under a great deal of attention, in both scientific research and manufactory, due to their broad potential applications in industry such as self – cleaning and antifogging materials[1,2]. Fabrication of superhydrophobic surfaces usually follows two conventions: initial structuring the micro/nanopattern to increase surface roughness and then covering a low surface – energy coating to decrease surface free energy of material.

However, the coating treatment can lead to problems in some practical aspects due to the degradation of organic compounds caused by UV radiation, abrasion or mechanical expenditure. Nowadays commercially available polymers like polypropylenes (PP), polyethylenes (PE) or cyclic olefin copolymers (COC) are widely used for direct patterning as low surface free energy materials with advantages of good functionality, flexibility, chemical stability and ease of processing.

In this paper we present systematic wetting properties study of nanostructured polypropylene (PP), functional foils, fabricated by roll – to – roll extrusion coating process (R2R EC). It is a fast and effective manufacture method, widely uses for smooth polymer films, which allows to large – scale replication of micro – and nanometric scale arrays onto polymer substrates[3]. Metal templates used for patterns imprint were prepared through a one step, maskless, black silicon etching process, what led to covering of the whole 4 inch silicon wafer area, and consequent NiV electroplating. By the manipulation of reactive SF_6 and O_2 gas steams, diverse nanograss topographies were generated. Figure 1 presents detailed process flow with images. R2R extrusion was performed under varied imprinting temperatures and extrusion speeds to control nanostructures replication quality. Wetting properties of fabricated PP foils were characterized by contact angle measurements of water sessile drop in static and dynamic method. We recorded values of static contact angles above 150˚ (Fig. 2) and roll – off angle in a range of 10 - 20˚ (Fig. 3) what indicates on superhydrophobic surfaces with self – cleaning potential applications.

References

1. S. H. Anastasiadis, "Development of Functional Polymer Surfaces with Controlled Wettability," *Langmuir*, no. 29, pp. 9277 - 9290, 2013.
2. J. Li, J. Zhu and X. Gao , "Bio-Inspired High-Performance Antireflection and Antifogging Polymer Films," *Small*, vol. 10, no. 13, pp. 2578-2582, 2014.
3. S. Murthy and et. al., "Fabrication of Nanostructures by Roll-to-Roll Extrusion Coating," Adv.Eng.Mat.,2015.

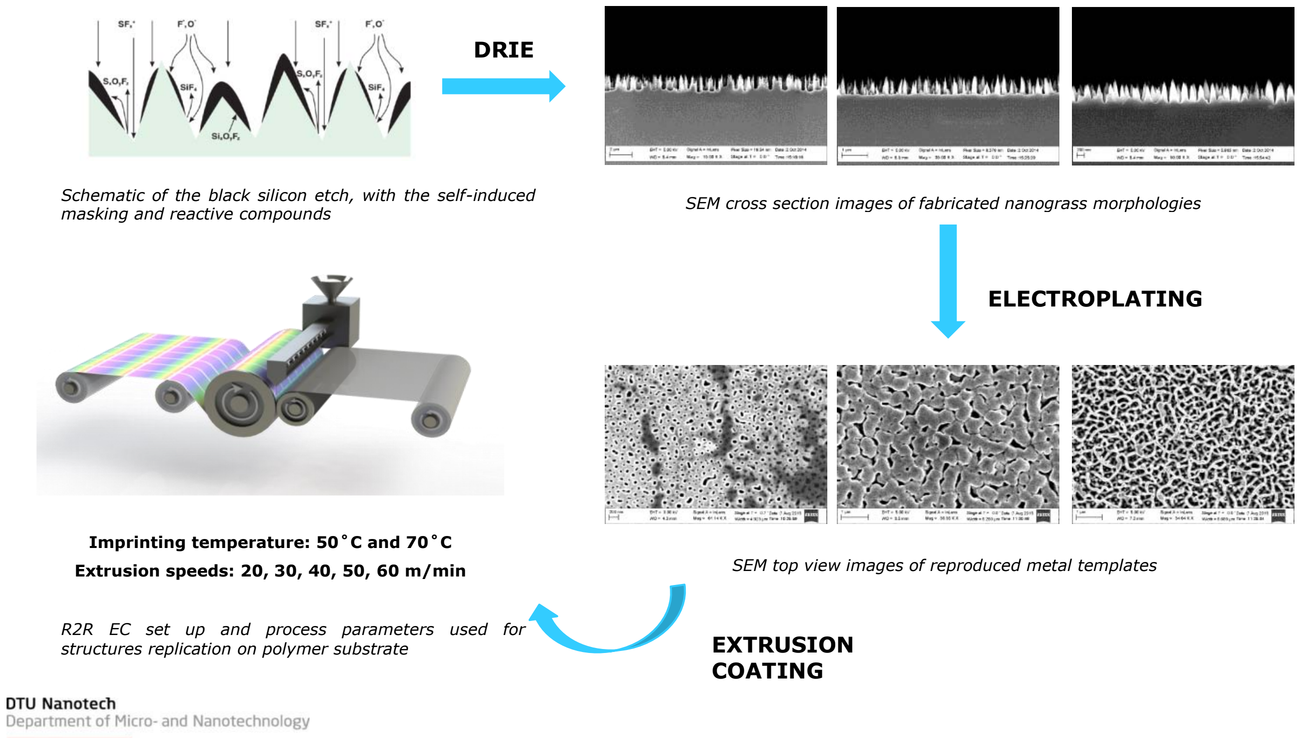

Fig.1 Fabrication process flow

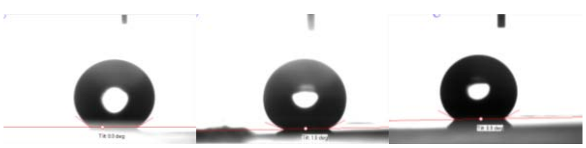

Fig 2. Dependence of static CA on various nanograss morphologies

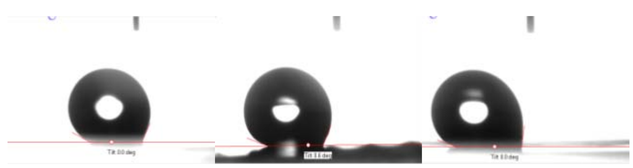

Fig 3. Dependence of roll-off angle on various nanograss morphologies