Nano, micro, or combination: design rules for self-cleaning surfaces

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Controlling the wetting properties of surfaces by nano and/or micro structuring is increasingly attracting the attention of the nanomanufacturing industry for a wide variety of applications in modern society. In this paper, we present the design rules and material aspects of using high throughput nanomanufacturing processes to realize self-cleaning polymer surfaces. In particular, based on Cassie Baxter and Wenzel models we have fabricated and studied the topographical effect of nano, micro and hierarchical features containing alternating filling factor schemes on the wetting properties of surfaces. An approximate 30% increase of the water contact angle (WCA) is observed between fluorosilane treated and non-treated surface at the nanoscale, while a 10% increase is observed once the features sizes are in the micro regime. At the macro scale (>10μm) no difference in the WAC is observed between the treated and non-treated surfaces. Furthermore, in both geometrical scales (nano and micro) a decrease in the WCA is observed once the overall filling factor is increased. Finally, we discuss the fabrication steps to realize both the master stamps and the imprint methods in order to replicate our surfaces over flat and free form surfaces. Conclusively, we demonstrate the utilization of such in automotive industry applications.

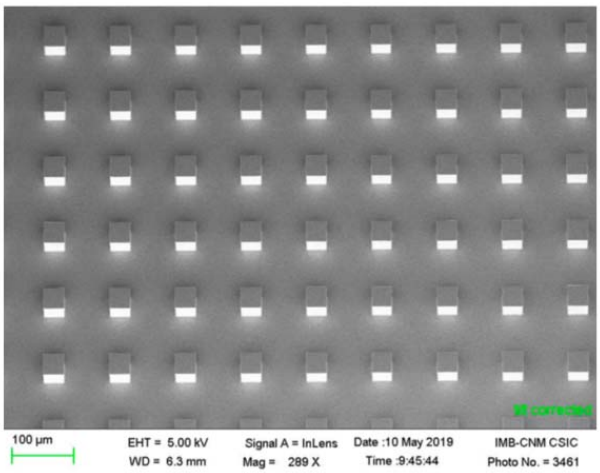

Figure 1. Tilted view SEM image of square shape array of silicon micro pillars presenting a WCA of 140°C.

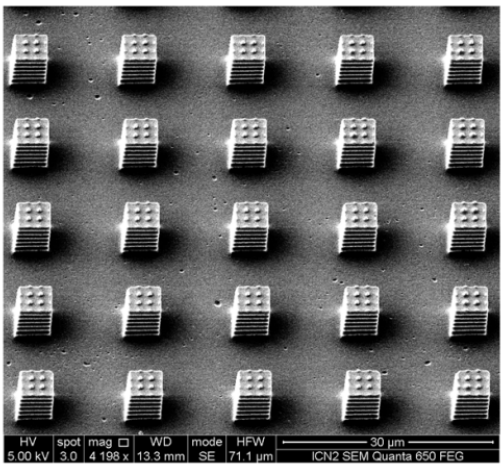

Figure 2. Tilted view SEM image of PMMA hierarchical micro/nano features presenting a WCA of 136 °C.

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