Superhydrophobic and superoleophobic surface using ZnO nano-in-micro hierarchical structure

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In nature, some organisms have surfaces with special functions.[1-7] The skin on the feet of a gecko with high adhesion capability allowing it to climb vertical surfaces,[2-3] the legs of a water strider enabling it to stand and walk upon a water surface,[4-5] and the surface of lotus leaf capable of self-cleaning by the rolling movement of droplets on the surface6-7 are all representative surfaces with special functions that occur in nature. Surfaces with such special functions are attributed to their structures composed of hierarchical micro and nanostructures.

Nature-inspired research studies aimed at fabricating artificial surfaces with functionalities identical to that of the surfaces present in natural organisms by replicating their hierarchical structures have been pursued actively.[8-14] Until recently, superhydrophobic hierarchical structures such as that in a lotus leaf have been fabricated by etching, lithography, sol-gel process, layer-by-layer self-assembly, electrochemical reaction, and deposition.[15] Although the fabrication of superhydrophobic hierarchical structures by these methods has afforded successful results, limitations such as limited applicability of substrates to fabrication, process complexity, and difficulty of large-area fabrication still remain.

In this study, we have developed superhydrophobic and superoleophobic surfaces based on ZnO nano-in-micro hierarchical structures on various large-area substrates. To fabricate the surfaces, ultraviolet nanoimprint lithography, a simple process enabling large-area pattering, was used in combination with hydrothermal synthesis. The wetting properties of the surfaces were analyzed by contact and sliding angle measurements with various solvents and by experiments determining self-cleaning properties. These analyses confirmed the superhydrophobicity and superoleophobicity of the fabricated surfaces.

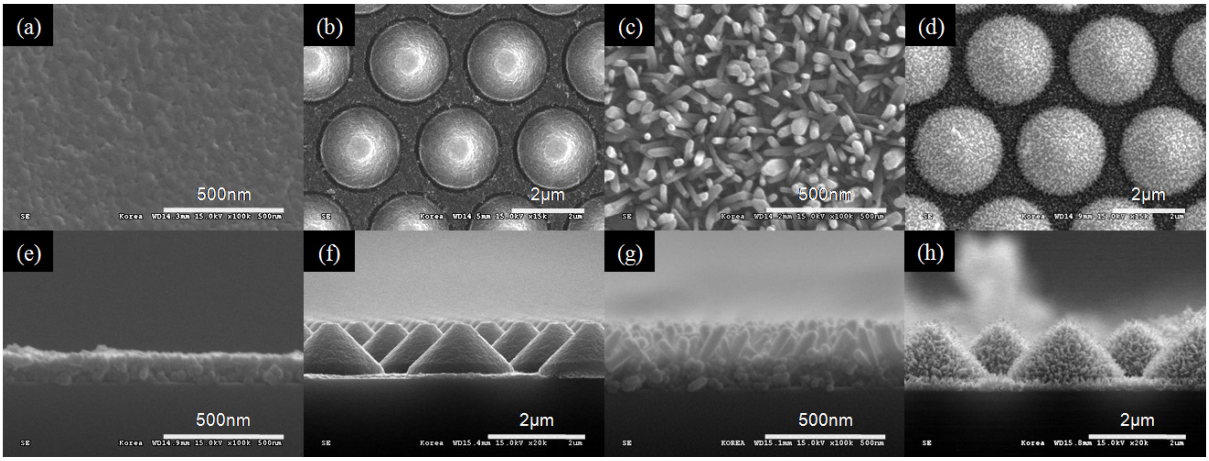

Figure 1. Four types of ZnO-polymer composites with different surface morphologies fabricated on Si substrates by a combination of UV NIL and hydrothermal synthesis using ZnO nanoparticle dispersion resin. (a, e), (b, f), (c, g), and (d, h) are the representative SEM images of the ZnO nanoparticle resin, micropattern, nanorods, and the hierarchical structure fabricated.

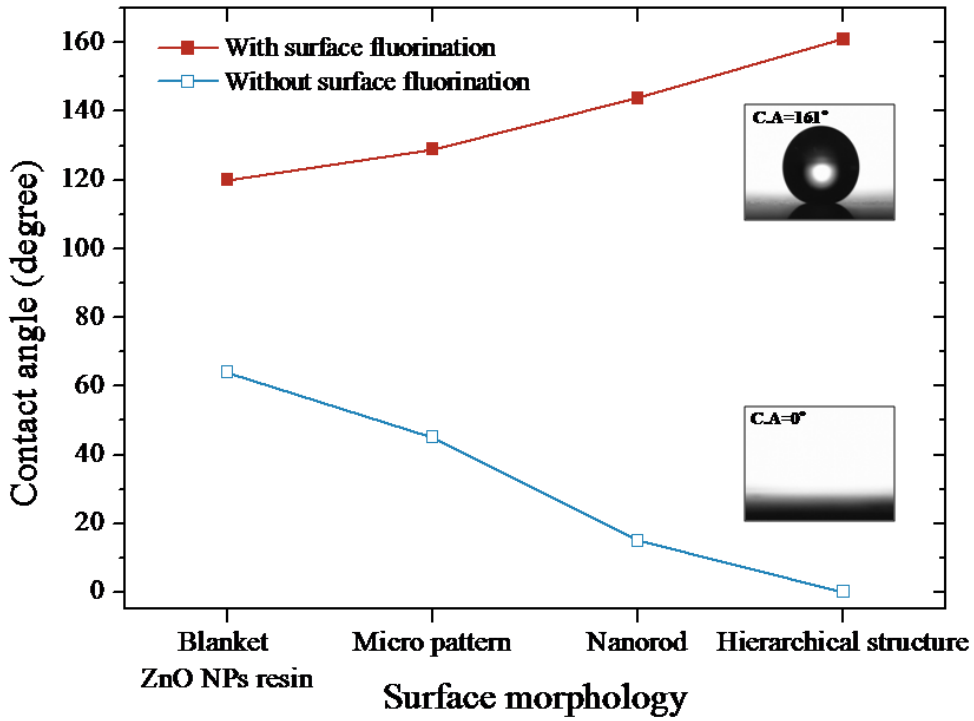

Figure 2. Results of the static contact angle measurements on the four types of ZnO-polymer composites conducted with DI water before and after surface fluorination