Wear Resistant Superhydrophobic Surfaces

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Superhydrophobic surfaces are most commonly achieved through the synergistic combination of micro-nanoscale surface roughness and low surface energy chemistry. A particularly versatile route to fulfill both requirements simultaneously is the so-called ”particles + binder” approach, in which a polymeric matrix acts as an adhesive that immobilizes rough particles onto a substrate while partially encapsulating them to impart hydrophobic character to the resulting texture. Li et al. [1] demonstrated this principle using PDMS as a glue with a broad variety of functional micro- and nanoparticles, showing that the decisive parameters governing superhydrophobicity are the aggregate size and surface hierarchy of the embedded particles rather than their intrinsic wettability (Figure 1) . Building on this concept, the present work employs a UV-curable silicone acrylate as the binder and surface-methacrylated fumed silica nanoparticles as the roughness-inducing filler. The critical advancement over physical embedding strategies lies in the chemical reactivity between the methacrylate groups grafted on the nanosilica surface and the acrylate functionalities of the binder: during UV-induced photopolymerization, covalent bonds form at the particle–matrix interface, anchoring the nanosilica into the crosslinked polymer network. This covalent integration is expected to substantially improve the mechanical durability of the coating, as interfacial bonding prevents particle detachment under abrasion.

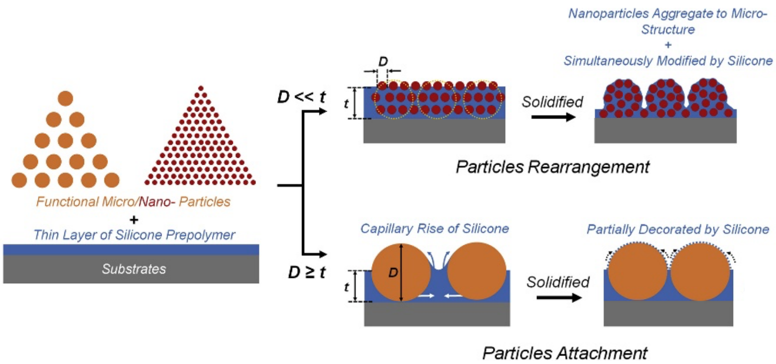

Figure 1 - Mechanism of particles + binder approach using PDMS prepolymer

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[1] Z. Li, M. Cao, P. Li, Y. Zhao, H. Bai, Y. Wu, and L. Jiang, Surface-Embedding of Functional Micro-/Nanoparticles for Achieving Versatile Superhydrophobic Interfaces, Matter **1**, 661 (2019).