SUPER DURABLE, ROBUST SUPER HYDROPHOBIC FABRICS

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Superhydrophobic surfaces with a water contact angle greater than 150° and low contact angle hysteresis have bio-mimicking anti-sticking, contamination resistant, and self-cleaning functions. Their emerging applications include oil-water separation, energy conversion, protection of electronic devices, controlling cell-substrate adhesion, and reducing fluid resistance for aquaculture and microfluidic devices. Fabrics having a superhydrophobic surface possess those unique features, but are still permeable to air and moisture, which are very useful for development of protective suits, healthcare products, and antifouling textiles.

The major issue facing existing superhydrophobic techniques is low durability to washing and abrasion. Despite the strategies developed to improve the coating durability, only limited success has been achieved in this area so far. For example, commercially available superhydrophobic fabrics lose the superhydrophobic feature after a few times of standard wash, and their abrasion durability is very poor also (only withstanding several hundreds of Martindale abrasion cycles). The poor durability has hindered the wide uses of superhydrophobic product in practice.

In our daily life, some polymeric composite materials have shown excellent durability. Taking car tyres as an example, the basic ingredients of tyres are natural rubber and carbon black, a carbon particle in the range of 50–600 nanometres. When a crosslinked rubber contains well-dispersed carbon black, its strength, wear resistance and UV aging resistance are drastically improved, making tyres very robust to withstand thousands of kilometres of running with tons of loading.

Inspired by this classic nanocomposite, we have used elastomeric polymer, polydimethylsiloxane, silica nanoparticles and fluorinated alkyl silane as the materials to produce a superhydrophobic coating on fabrics. The coated fabrics maintain their superhydrophobicity during their use lifetime, which can withstand 500 cycles of washing and 28 000 cycles of heavy abrasion, and even be boiled water for several hours, without changing the superhydrophobicity. The coating is also super stable against strong acid (pH=1), strong alkali (pH=14).

In textile area, the wide use of superhydrophobic fabrics would significantly reduce the waste of water resources in laundering. A recent study from Denmark on the lifecycle of textiles found that out of all the energy consumed over a typical textile lifetime from manufacture to disposal, 78% of that energy is consumed in washing, drying and ironing. Superhydrophobic coatings would significantly reduce not only the energy required for washing and drying, but also save 500 million litres of water consumption each week for laundering in Australia.

Such a durable, robust superhydrophobic fabric will be very useful for development of smart textiles for various functional applications.