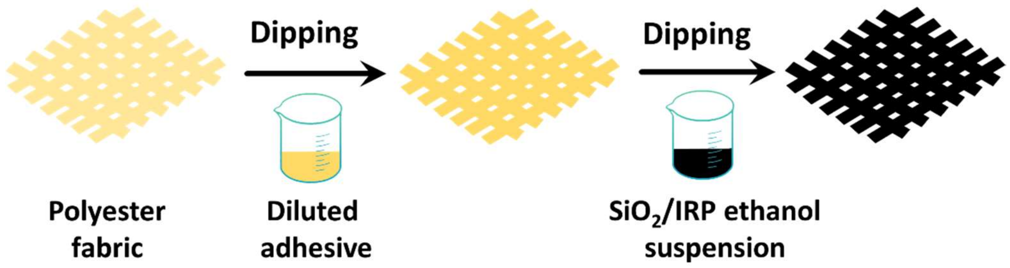
How contact angle measurements can help to keep you cool in summer.

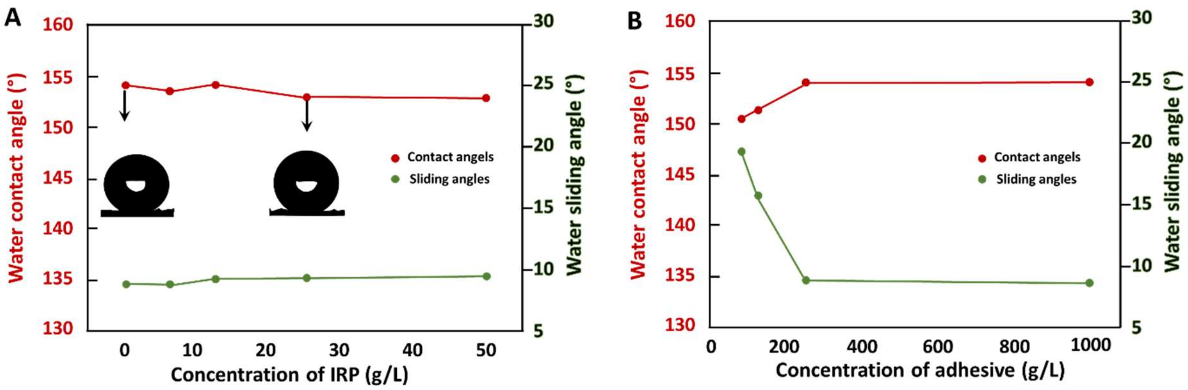
Solar energy is our essential source of renewable and inexhaustible energy, which is absorbed by the Earth's land surface, oceans, and atmosphere. However, high temperatures also make people feel uncomfortable requiring the use of air conditioners which are highly energy intensive. This energy amount can be reduced if better ways for isolation would be accessible. Researchers have exerted many efforts to design effective materials for thermal insulation, and reduction of solar energy absorption. For example, by doping traditional pigments with transition metals or rare-earth metal oxide, it was possible to generate infrared-reflective films on textiles. Unfortunately, dust easily deposits on the surface of these materials and affecting the capability of the material to reduce the solar energy absorption. In addition, the mechanical stability and air permeability were limited which are in fact two of the key parameters for good textiles. To overcome these drawback, Feng and coworkers fabricated polyester fabrics with an excellent infrared-reflective performance, superhydrophobicity, high mechanical stability and breathability.

To study the effects of different materials on infrared-reflectivity of a surface, a thin layer of diluted styrene-butadiene rubber adhesive was dip coated on textile fibers, and black infrared-reflective pigments (IRP)/SiO_2 suspension was introduced by a second dipping process (**Picture 1**). To study the effect of different infrared-reflective pigments contents on the superhydrophobicity properties, they conducted water contact angle measurements on surfaces with different IRP contents (IRP/SiO_2 suspension with different concentrations were used I the coating process; SiO_2 37.5 g/L, IRP 0-50 g/L) and compared the pristine polyester fabric.



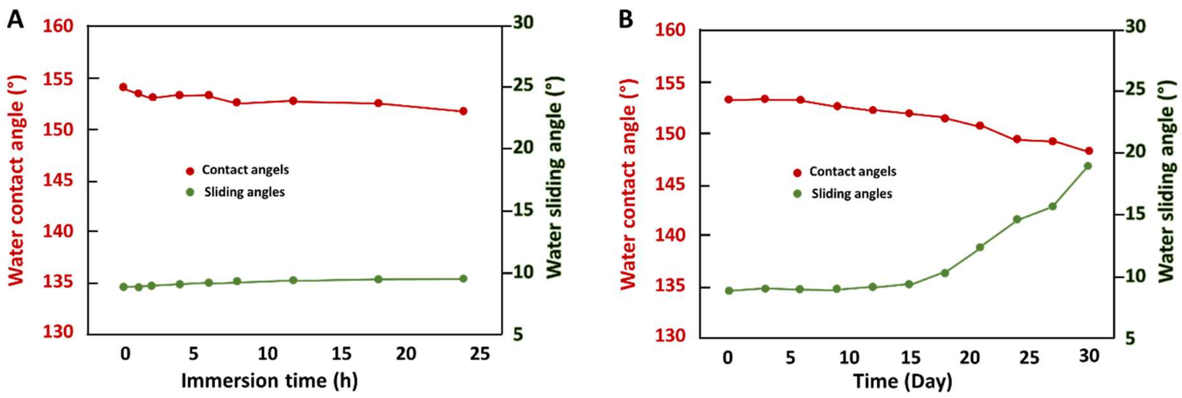
Picture 1: *Preparation process for the superhydrophobic coatings on polyester fabrics*

Due to the addition of micro- and nanoparticles and the thus increased roughness, all samples exhibited an increased contact angles (CAs) of ~154° and decreased sliding angles (SAs) of ~9° compared to the pristine sample without any treatment (CA ~132°, SA ~70°) (**Picture 2A**). With increasing IRP concentration, the CAs kept almost constant and the superhydrophobicity remained mostly unaffected. Likewise, the water drops remained spherical the coated samples samples for more than 2 h whereas they spread out and expanded completely on the pristine fabric over ~90 s.



Picture 2: *A) Water contact angles and sliding angles of superhydrophobic fabrics with various infrared-reflective pigments (IRP) concentration; B) Water contact angles and sliding angles of the superhydrophobic fabric surface against different concentrations of adhesives*

In addition, the air permeability of the fabrics was studied. Considering the effect of the adhesive on both the hydrophobicity and the air permeability, they found 250 g/L adhesive was the optimum concentration for preparing fabrics with high hydrophobicity **(picture 2B)** and good air permeability (325 mm/s). As mentioned before, the mechanical stability and air permeability both play important roles in textiles preparation. Hence a sandpaper abrasion test was used to demonstrate the mechanical stability of the superhydrophobic surface. Even when exposed to 30 abrasion cycles at 0.68 kPa pressure, the treated fabric still possessed a good superhydrophobicity with CAs of more than 150° and SAs less than 10°. **Picture 3A** displays that the fabric maintains stable with almost unaffected CAs and SAs over 24 h immersion in dirty water. This effect is attributed to the absence of polar chemical groups on the treated fabric surface. Furthermore, they placed the samples on an outdoor windowsill and studied the effect of outdoor placement on the wettability of the fabrics. As shown in **Picture 3B**, after 30 days, the fabrics still showed good hydrophobicity.



Picture 3: *A) Water contact angles and sliding angles of the superhydrophobic fabric surface over 24 h immersion in dirty water; B) Effect of 30 days outdoor placement on the wettability of the superhydrophobic fabric.*

The infrared reflectance (780 ~ 2500 nm) was measured over 30 days showing a slight decrease (decreased by 3.9% over 15 days and 8.1% over 30 days). However, the average infrared reflectance of the samples without SiO_2 nanoparticles treatment dramatically decreased by 19.3% over 15 days and 36.1% over 30 days, respectively. It can be concluded that the superhydrophobic fabric with an infrared-reflective property had excellent outdoor stability.

Overall, the authors prepared a robust fabric with an outstanding infrared-reflective property, anti-fouling property, mechanical stability and air permeability. The stability of the material towards environmental conditions was followed by wetting analysis as a fast and non-destructive way to quantify changes of the surface chemistry.

An optical contour analysis system OCA (DataPhysics Instruments GmbH, Germany) was used in this research.

For more information, please refer to the following article:

Robust, infrared-reflective, superhydrophobic and breathable coatings on polyester fabrics; Jian Lv, Xiangwei Kong, Chenxi Zhu, Jing Zhang, Jie Feng; *Progress in Organic Coatings* **2020***,* 147, 105786; DOI: 10.1016/j.porgcoat.2020.105786