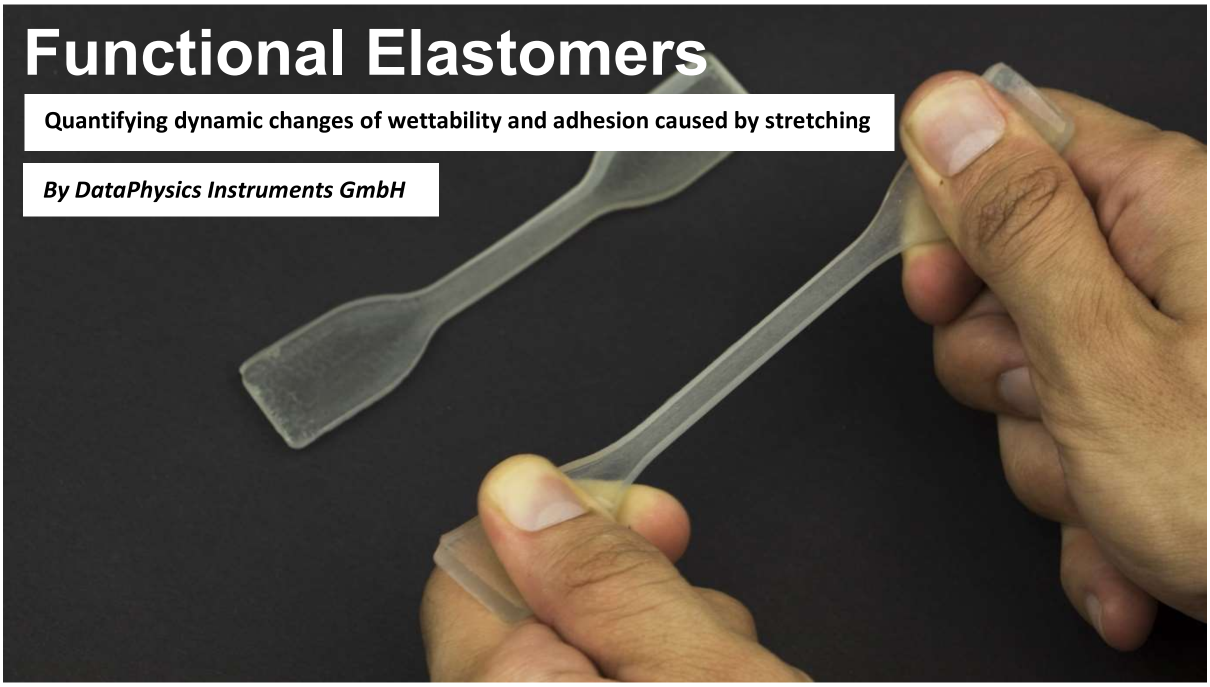
How to impart switchable wettability and adhesion on elastomer films



Controlling the dynamic wetting behaviour of droplets on smart surfaces has recently attracted increasing interest due to a variety of potential applications in drug delivery, liquid transfer, microfluidic devices, anti-fog and anti-icing surfaces, etc. A lot of studies have been done in this field exploring the effects of changing chemical composition and varying surface structure geometry. Also, external stimuli (e.g. mechanical stress, temperature, electricity, etc.) were used to achieve controllable motion of liquid droplets on elastomer surfaces. Although much progress in this area was made, the problems of fast response and contamination resistance are still not solved. Recently, Jiang *et al.* reported a strategy to manage droplet manipulation and transportation dynamically on electric field adaptive superhydrophobic elastomer surfaces without loss and surface contamination.

In this work, a superhydrophobic elastomer film was formed by micro/nanostructured clusters of hydrophobic TiO_2 particles on an elastomer film. On the basis of these micro/nanostructures the surface wetting behaviour can be enhanced from hydrophobic to superhydrophobic by adjusting the space of the micro/nano-structured clusters on the surface (**Figure 1**). The wetting state switches between Cassie state and Wenzel state and also the adhesion on the surface can be tuned.

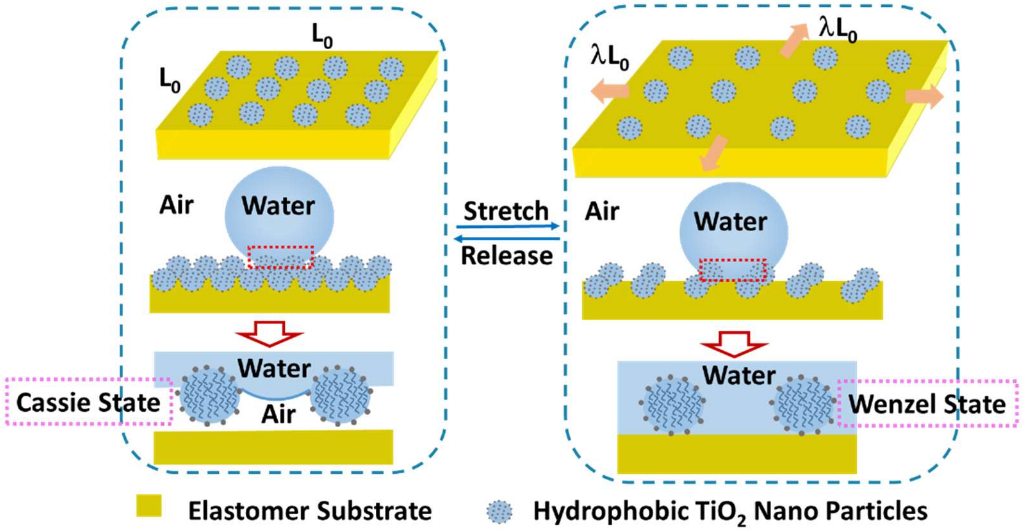


Figure 1. *Controllable wettability of elastomer films by adjusting the space of micro/nano-structured clusters of TiO_2 nanoparticles on the surface through stretching.*

To get a deeper understanding how the surface wettability is affected by the distance between the micro/nanostructured clusters, well controlled stretching processes were conducted. **Figure 2A** illustrates how the contact angle (CA) on the micro/nanostructured surface decreased with an increase of the stretch ratio of the elastomer film. Besides, further results showed that the surface wettability can even change from superhydrophobic to hydrophilic (CA from 152° to 89°) by increasing the distance of the micro/nanostructured clusters (λ from 1 to 9), which is similar to the unmodified elastomer film. The micro/nanostructured elastomer film is durable and displays good reversible wettability transition even after repeated stretch-release cycles (20 times between λ = 1 and 4.5).

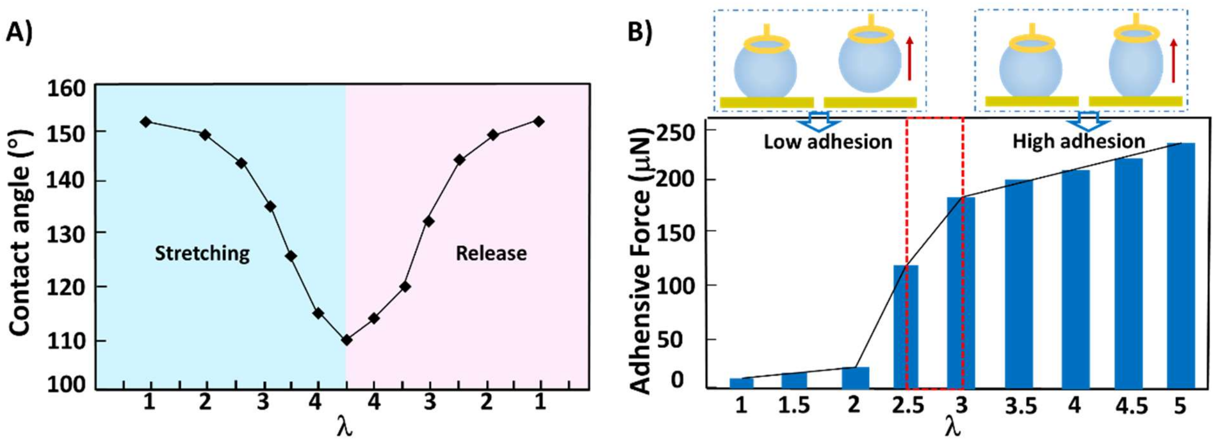


Figure 2. *A) Reversibly tuneable surface wettability by stretching and releasing the elastomer film from λ= 1 to λ = 4.5. B) Dynamic adhesion performance of the micro/nanostructured elastomer film with varying stretch ratios (λ).*

The dynamic wetting and adhesion behaviour of the surface were also significantly influenced by the TiO_2 particles on the elastomer film. Droplet can be lifted up easily from the micro/nanostructured elastomer film when λ is between 1 and 2, whereas the droplet sticks onto the surface and even detached from the adhesion probe when the stretch ratio is higher than 3. The adhesive force of the droplet on the micro/nanostructured elastomer film is stronger with larger stretch ratios (**Figure 2B**). The adhesive force increased suddenly when the stretch ratio changed from 2.5 to 3, indicating the critical stretch ratio for the stretching process.

Overall, this work provides a novel approach for achieving switchable wettability from Cassie state to Wenzel state and adjustable adhesion on elastomer films via altering the micro/nanostructured clusters distance on the surfaces. By applying an additional electrical field, the droplet motion states on the superhydrophobic elastomer surface could be dynamically controlled without any loss and contamination.

An optical contour analysis system OCA and a dynamic contact angle measuring devices and tensiometer DCAT (DataPhysics Instruments GmbH, Germany) were used in this research.

For more information, please refer to the following article:

Switchable Wettability and Adhesion of Micro/Nanostructured Elastomer Surface via Electric Field for Dynamic Liquid Droplet Manipulation; Yan Li, Jinrong Li, Liwu Liu, Yufeng Yan, Qiuya Zhang, Na Zhang, Linlin He, Yanju Liu, Xiaofang Zhang, Dongliang Tian, Jinsong Leng, and Lei Jiang; *Adv. Sci.,* **2020**, 2000772*;* DOI: 10.1002/advs.202000772