How contact angle and adhesive force measurement can help the fight against COVID-19.

Virus-surface contact plays a key role in the transmission of respiratory diseases like the new global pandemic Coronavirus Disease 2019 (COVID-19). The virus-loaded droplets are released from infectious individuals via talking, sneezing, singing, coughing, etc. When these droplets land on objects they can lead to indirect infections once someone transmits them by e.g., touching the surface and their eyes. Therefore, suppressing droplet adhesion on surfaces that might get into contact with humans is a highly efficient way to interrupt the transmission of infectious materials. Water droplets exhibit a good mobility on superhydrophobic surfaces with a low contact angle hysteresis (CAH < 10 ^{o}C) due to their low adhesive force. Such functional surfaces have been widely utilized in anti-biofouling, droplet manipulation and self-cleaning materials. It is of great significance to develop new superhydrophobic surfaces to prevent the transmission of infectious materials. Recently, Zhu et al. have presented that superhydrophobically coated silica nanoparticles exhibited a significant reduction in virus-loaded droplet attachment and confirmed that materials with these superhydrophobic surfaces could be a way to stop virus transmission chains in the current COVID-19 pandemic.

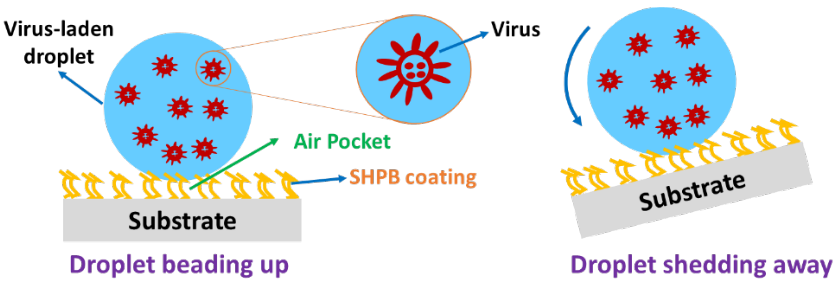

Fig. 1 *illustration of the virus-loaded droplet beads on a superhydrophobically coated surface rolling off with the goal to avoid deposition of infectious droplets.*

In this work, two superhydrophobic coatings were applied on silanized silica nanoparticles (Glaco coating and Aerosil coating). These coated silica nanoparticles were then applied as the surface finish on different substrates. On these coatings the virus-loaded droplet shows a non-wetted Cassie state (the droplets float on the coated structures with air pockets in between) significantly decreasing the solid-liquid contact area as well as the probability of virus-surface contact (Fig. 1). From these surfaces the virus-loaded droplet rolls off easily, reducing the chance that virus material adheres.

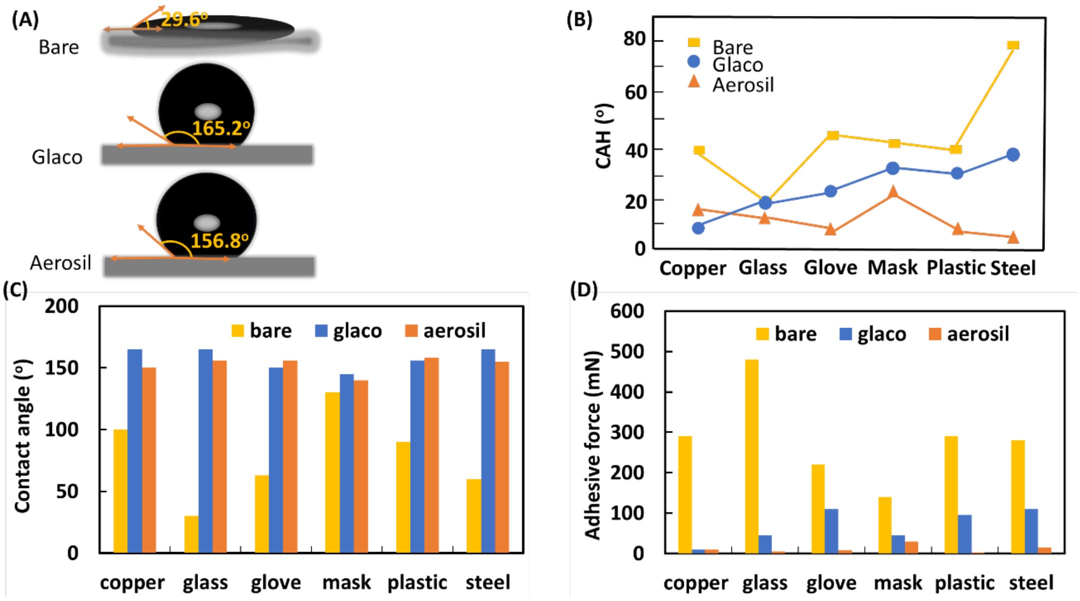

***Fig.2.** A) CA measurements on bare, Glaco and Aerosil coated glass surfaces. CAH (B), CA (C), and adhesive force (D) measurements on different substrates.*

To understand the effects of superhydrophobic coatings on inhibiting fomite formation, the wettability of various superhydrophobically coated surfaces was studied. The two coatings remarkably lowered the wettability of the surfaces as shown in Fig 2. Fig 2A shows that the wettability of glass substrate changes from hydrophilic to superhydrophobic upon coating with Glaco or Aerosil. In most cases, the contact angles (CAs) on Glaco coatings are slightly larger than that on Aerosil coatings, but much larger than on bare surfaces (Fig. 2C). Besides, as shown in Fig. 2B, the contact angle hysteresis (CAH) on the two coating covered surfaces are much smaller than on the bare surfaces, which indicates that the adhesive forces of the droplets on superhydrophobic surfaces is much lower than on the bare surfaces. The results of the adhesive force measurements in Fig 2D are consistent with the CA measurements. Besides, the CAH and adhesive force are important parameters to characterize the sticky state of a surface, the smaller CAH and adhesive force are, the less sticky is the surface. For a less sticky surface, fewer virus-loaded liquid residues were left after contact, which was confirmed by the measurement of residue ratios m_r/m_0 (Fig. 3). A smaller amount of liquid residue is left after touching the less sticky surfaces, which would lead to higher effectiveness in preventing viral droplet adhesion.

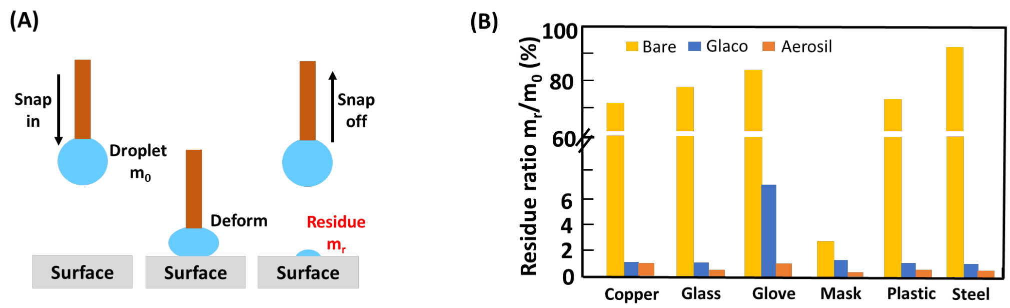

***Fig 3** A) Scheme of the measurement of residue ratio m_r/m_0, in which m_r and m_0 are the mass of liquid residue and droplet, respectively. B) The residue ratio m_r/m_0 on different surfaces.*

To verify this point, the viral activity on superhydrophobically coated surfaces was studied. Fig 4A shows that the speed of virus gene copy is clearly slower on superhydrophobic surfaces than on hydrophilic surfaces. Notably, as shown in Fig. 4B, viral activity has a positive correlation with adhesion, which suggests that superhydrophobic surfaces with lower adhesive force are endowed with a better ability to prevent virus spreading.

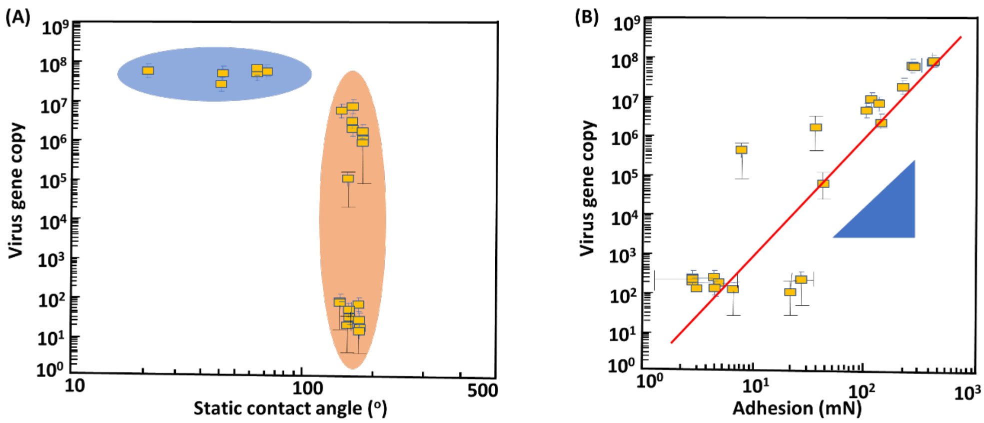

***Fig. 4** Correlation between surface wettability and viral adhesion.*

This work studied the influence of surface wettability on the viral adhesion and activity, which confirmed that superhydrophobic surfaces with low adhesion exhibit a good performance in suppressing fomite formation by repelling virus-loaded droplets. It demonstrates that superhydrophobic surfaces can potentially prevent fomite formation and can help the fight against the COVID-19 pandemic or other respiratory diseases.

The contact angles, adhesive forces and liquid residue ratios were measured with an Optical Contour Analysis system of the OCA series and a Dynamic Contact Angle measuring device and force Tensiometer of the DCAT series by DataPhysics Instruments GmbH, Germany.

For more information, please refer to the following article:
Superhydrophobicity preventing surface contamination as a novel strategy against COVID-19; Pingan Zhu, Yixin Wang, Hin Chu, Liqiu Wang; *J. Colloid Interface Sci.*, ***2021****, 600, 613*; DOI: 10.1016/j.jcis.2021.05.031.