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Buoyancy increase and drag-reduction through a simple superhydrophobic coating†

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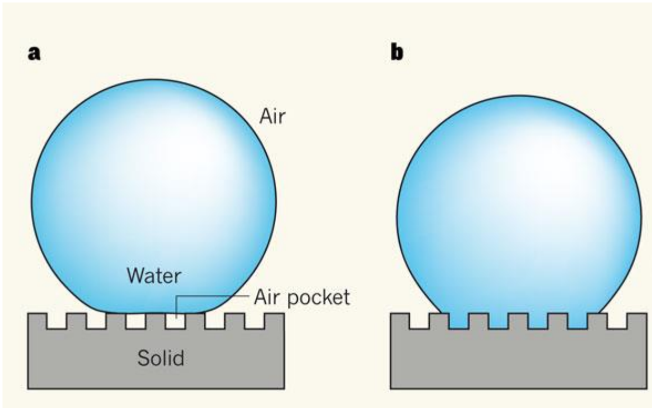
Bioinspired

Avijit Baidya
08.07.17

Contact angle and droplet shape

Wenzel



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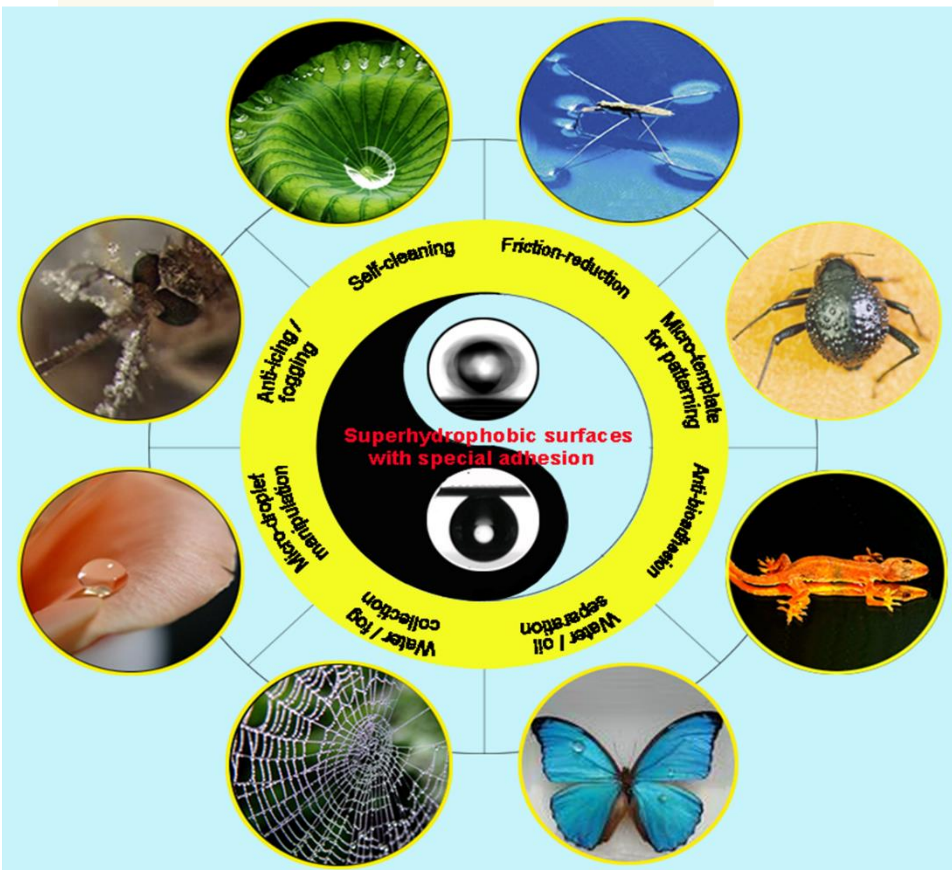
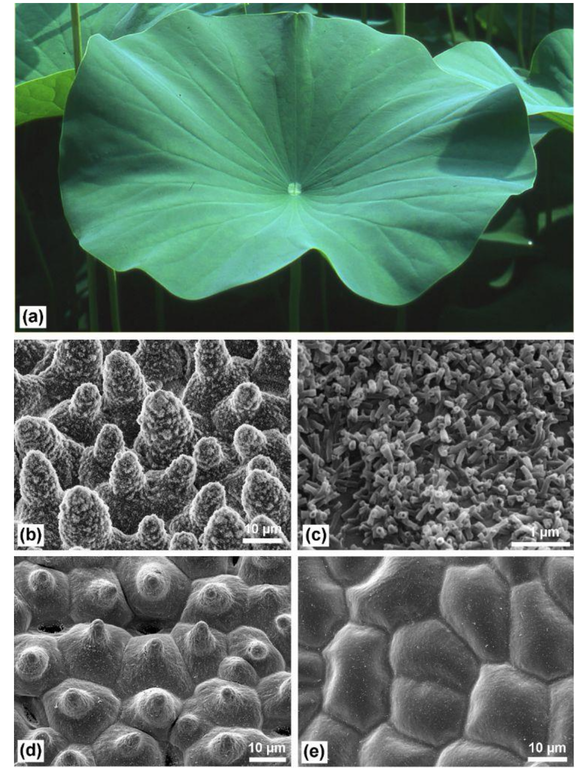




Introduction…

- In nature, the water strider is an insect that uses superhydrophobic surfaces.

- The micro structures (nanosized hairs with nanogrooves) of the strider's leg allow the insect to float, slide, and jump on the surface of water, **and a single leg of the insect can support approximately 15 times its total body weight.**

- This shows that the aquatic application of superhydrophobic surfaces has the potential to significantly improve buoyancy and/or reduce water drag.

- Previous studies have shown that a superhydrophobic coating made it possible for a box made with a copper mesh to float on water.

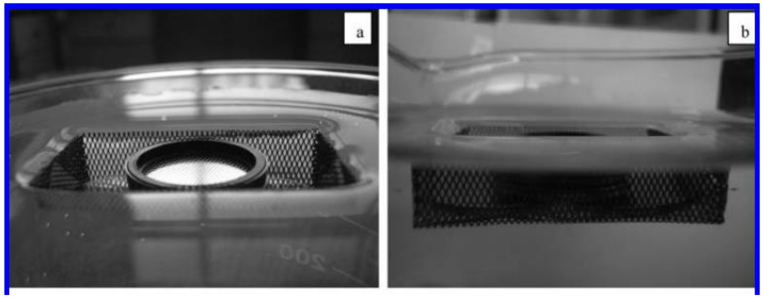
- Increased **loading capacity** of several hundred milligrams was believed to have occurred due to the **air bubbles entrapped by the superhydrophobic surface.**

Previous study…

Miniature Boats with Striking Loading Capacity Fabricated from Superhydrophobic Copper Meshes

Qinmin Pan, and Min Wang

ACS Appl. Mater. Interfaces, **2009**, 1 (2), 420-423• DOI: 10.1021/am800116d • Publication Date (Web): 07 January 2009



A Water Strider-Like Model with Large and Stable Loading Capacity Fabricated from Superhydrophobic Copper Foils

Qinmin Pan,* Jia Liu, and Qing Zhu

Bioinspired Oil Strider Floating at the Oil/Water Interface Supported by Huge Superoleophobic Force

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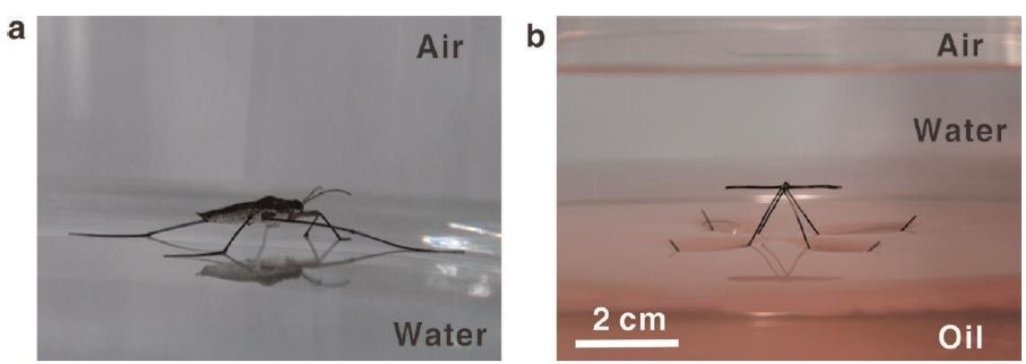

In this paper…

- A superhydrophobic paint was fabricated using 1*H*,1*H*,2*H*,2*H*-perfluorooctyltriethoxysilane (PFOTES), TiO_2 nanoparticles and ethanol.

- The superhydrophobic coating has potential for aquatic application as it induces **increased buoyancy and drag reduction**.

- Buoyance testing showed that the reduction of surface energy by superhydrophobic coating made it feasible that glass, **a high density material**, was **supported by the surface tension of water**.

- In a boat sailing test, it was shown that the low energy surface treatment **decreased the adhesion of water molecules** to the surface of the boat resulting in a reduction of the drag force.

- Additionally, a robust superhydrophobic surface was fabricated through layer-by- layer coating using adhesive double side tape and the paint, and after a 100 cm abrasion test with sand paper, the surface still retained its water repellency, enhanced buoyancy and drag reduction.

Results and Discussion…

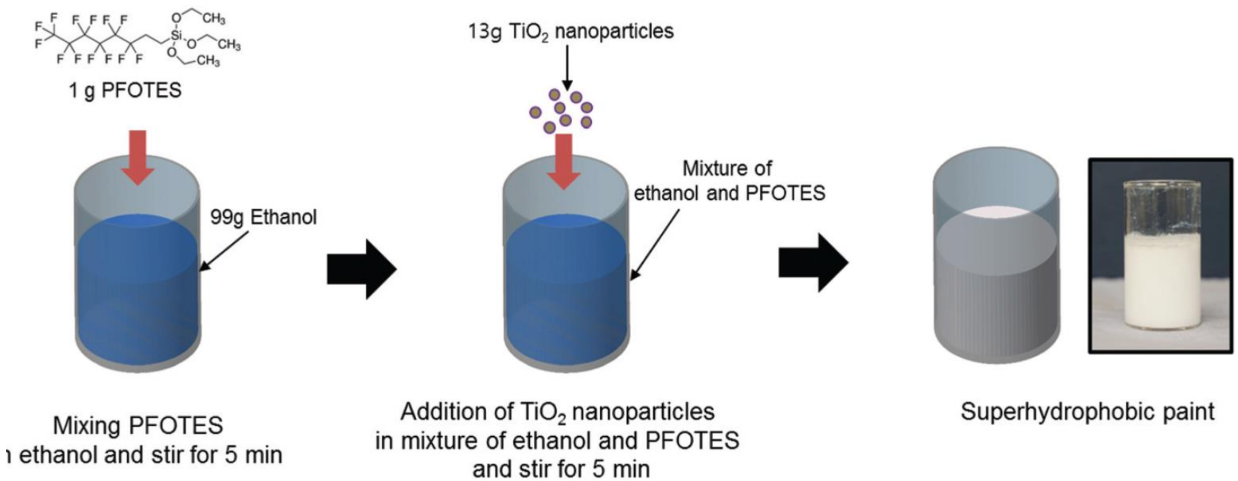

Fig. 1 Preparation of superhydrophobic paint.

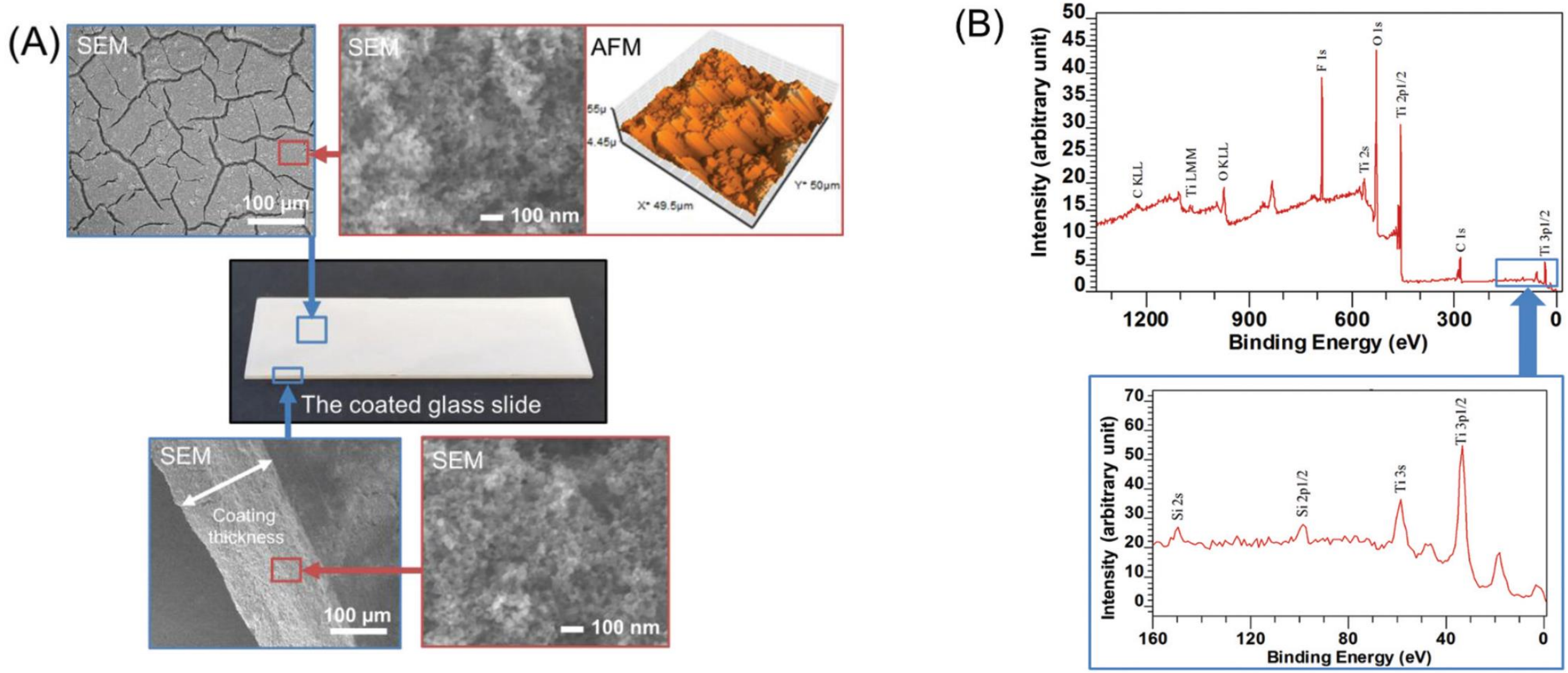

Fig. 2 (A) SEM and AFM image of glass slide coated by the superhydrophobic paint, and (B) the XPS pattern of the superhydrophobic paint.

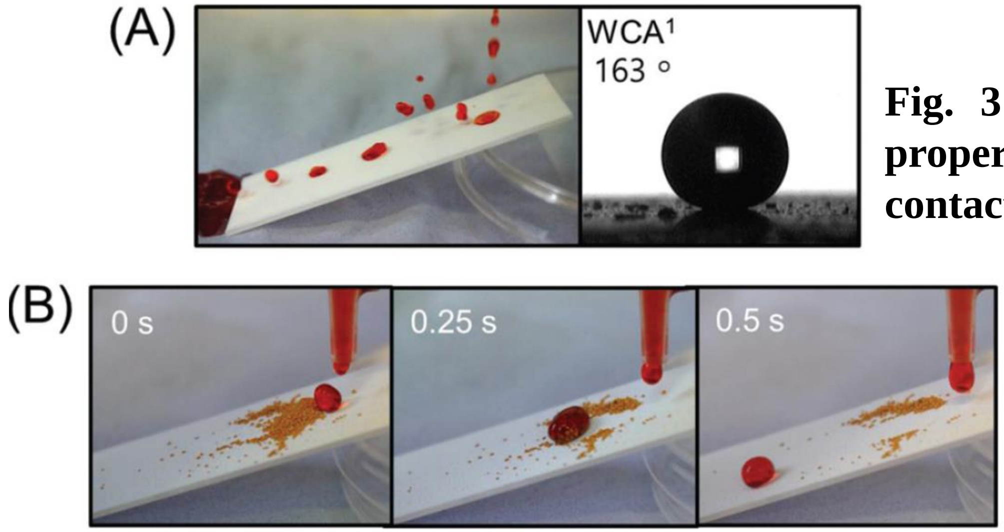

Fig. 3 (A) Water repellent and (B) self-cleaning properties of the coated glass slide. 1 WCA: water contact angle.

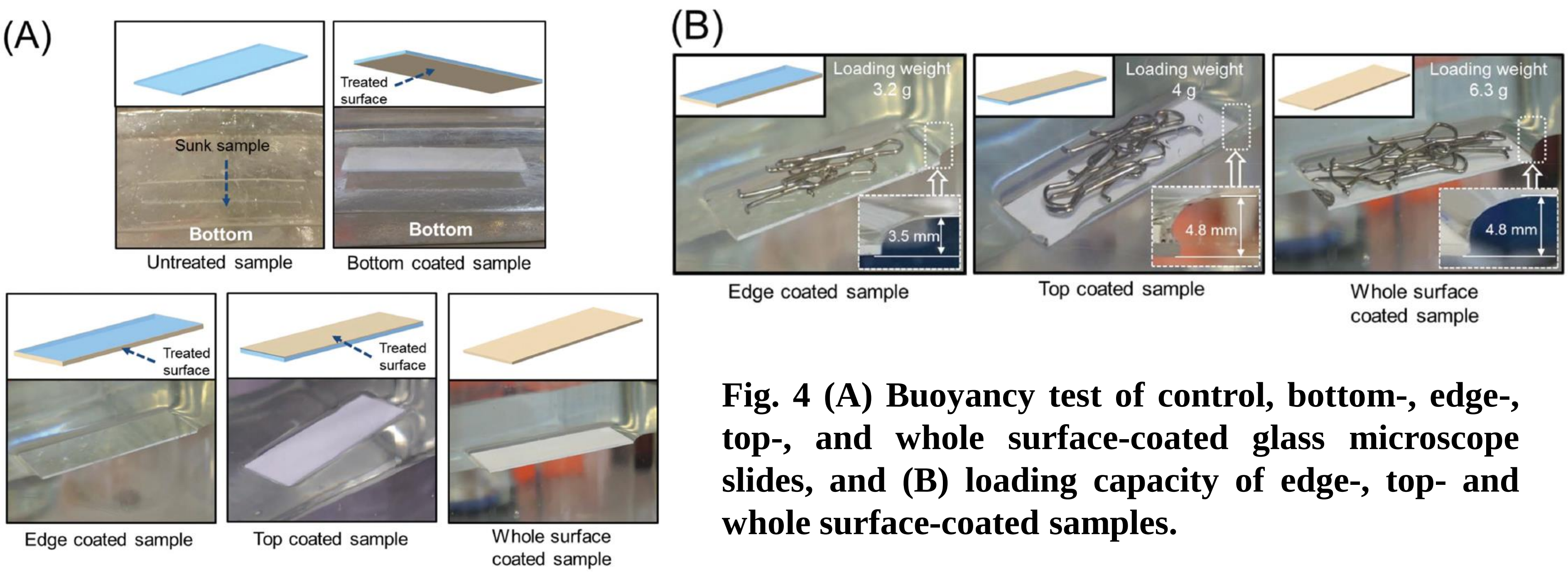

Fig. 4 (A) Buoyancy test of control, bottom-, edge-, top-, and whole surface-coated glass microscope slides, and (B) loading capacity of edge-, top- and whole surface-coated samples.

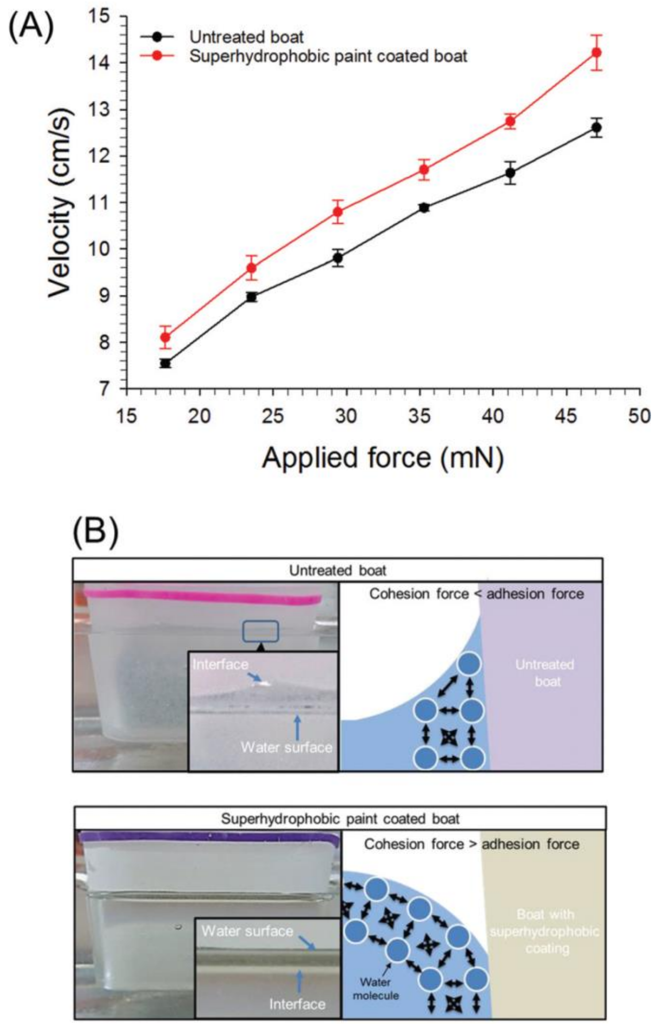

Fig. 5 (A) Sailing test of the untreated boat and the superhydrophobic paint coated boat, and (B) adhesion of water molecules on the boat's surface before and after superhydrophobic coating.

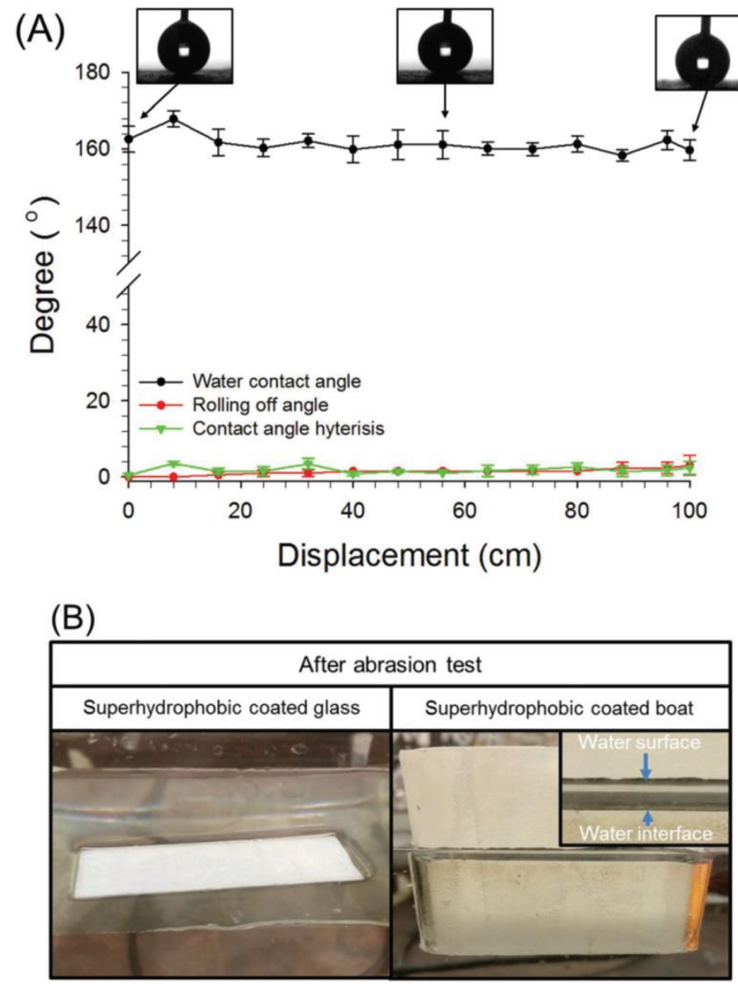

Fig. 6 (A) Estimation of water contact angle, contact angle hysteresis, and rolling off angle on treated samples after abrasion test using sand paper, and (B) treated glass sample floating on water and adhesion of water molecules on the surface of the treated boat after the 100 cm abrasion test.

Conclusion

- Superhydrophobic paint was fabricated and its potential for aquatic application was determined.

- Buoyancy testing showed that the reduction of surface energy by the superhydrophobic coating makes it feasible that glass is supported by the surface tension of water.

- The sailing test showed that the low surface energy decreased the adhesion of water molecules onto the surface of a boat, resulting in a reduction of the water drag force.