Phase I Scientific Report

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Our goal in this GCE phase I project was to create a superhydrophobic (super water-repeling) metal surface. Six months into the phase 1 project, we have successfully achieved this goal.

As outlined in our Phase I proposal, my lab had pioneered a laser surface structuring technique that allowed us to transform regular materials to superhydrophilic (water bonding), regardless their intrinsic wetting property. Based on the know-hows on creating the superhydrophilic surface, we set out to create the counterpart technique of making a superhydrophobic (super water repeling) metal surface. As discussed in the Phase I proposal, a superhydrophobic material will repel wastes and collect clean water with virtually no external energy needed. Therefore, the creation of superhydrophobic materials can potentially bring a leap forward in sanitation technology.

Up to this point in our phase I project, we successfully developed a superhyphobic metal surface through high-intensity femtosecond (fs: 1 fs = 10^{-15} sec) laser surface processing. Essentially, we create a unique pattern of surface structures on a metal, and these structures turn the regular metal superhydrophobic. A demonstration of this superhydrophobicity is shown in Figure 1, where a drop of water is released and falls towards the treated surface. Remarkably, the water droplet is repelled by the treated surface to such a degree that it bounces off the surface, lands again due to the gravity, and bounces again and slides off from the treated surface. In this demonstration, we tilt the metal surface at a small angle of 4°, and this small tilt is more than sufficient to push the water off the surface with only two bounces. The whole process lasts for only 1 second, and the laser-treated surface remains completely dry afterwards [Fig. 1(f)]. As a result, the superhydrophobic surface also has a self-cleaning and anti-biofouling effect. To test this, we put a layer of dust particles on the superhydrophobic surface area and start to drop water onto the treated area. As water is repelled, so are the dust particles. As a comparison, water sticks to a regular untreated metal surface even upside down.

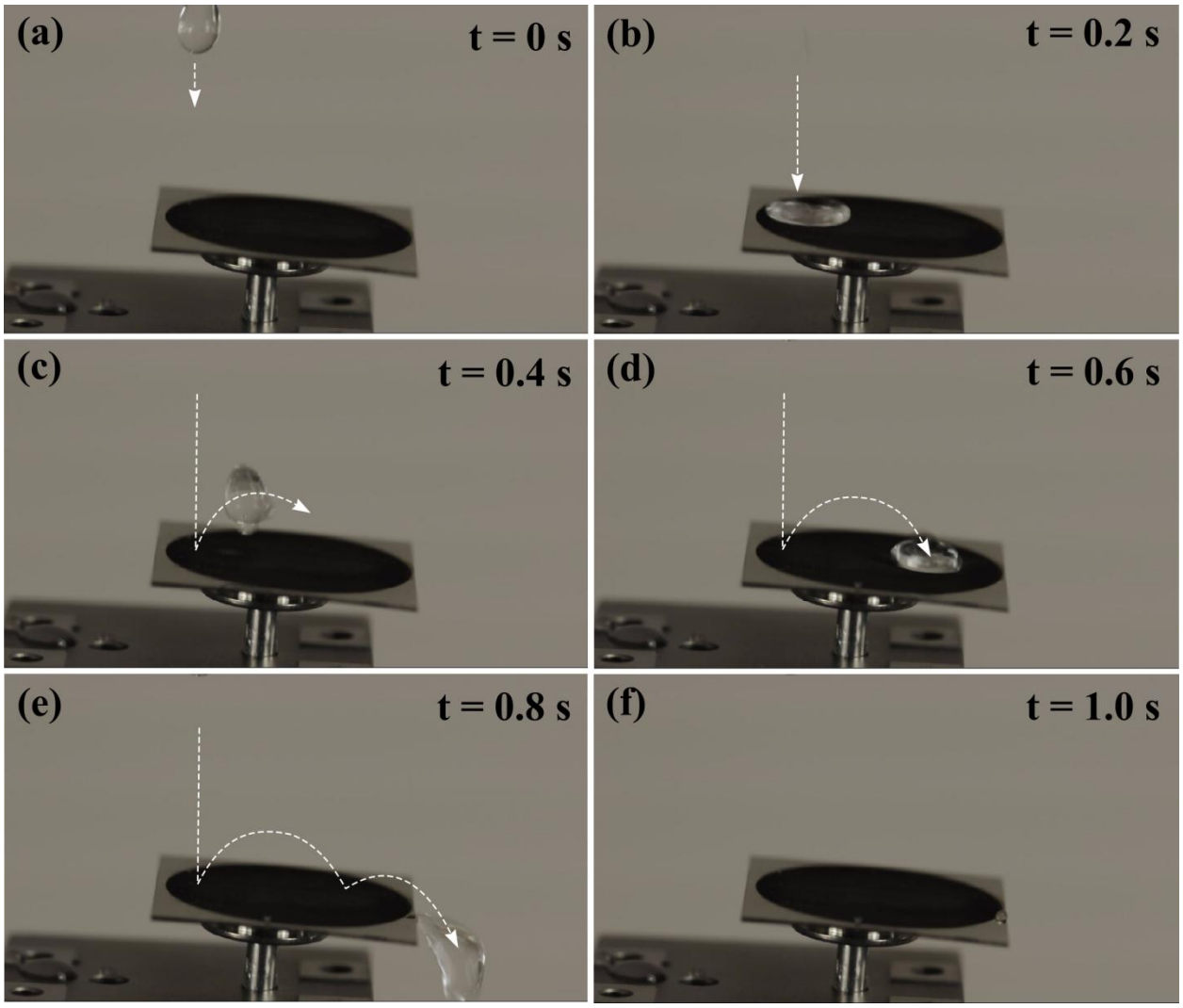

Figure 1. Snapshots of a water droplet bouncing off the superhydrophobic metal surface produced in our Phase I project. The frames are taken at a 0.2 sec interval. The metal surface is slightly tilted to about 4°.