Electronic Supplementary Material

A Miniature Droplet Reactor Built on Nanoparticle-Derived Superhydrophobic Pedestals

Bin Su, Shutao Wang, Yanlin Song, and Lei Jiang (✉)

Beijing National Laboratory for Molecular Science (BNLMS), Institute of Chemistry, Chinese Academy of Sciences, Beijing 100190, China

Supporting information to DOI 10.1007/s12274-010-0078-5

Structural information and superhydrophobicity of superhydrophobic pedestals

The "glue and nanoparticles" method provided a facile and quick technique to form superhydrophobic coatings on various pedestals. Figure S-1(a) presents the top-view SEM image of a composite coating on a glass plate. Commercial hydrophobic silica nanoparticles aggregated and generated rough three-dimensional structures following rapid evaporation of the chloroform solvent. The cross-sectional SEM image of the composite coating is shown in Fig. S-1(c). Owing to the low density (50 g/L), numerous silica nanoparticles were inclined to float on

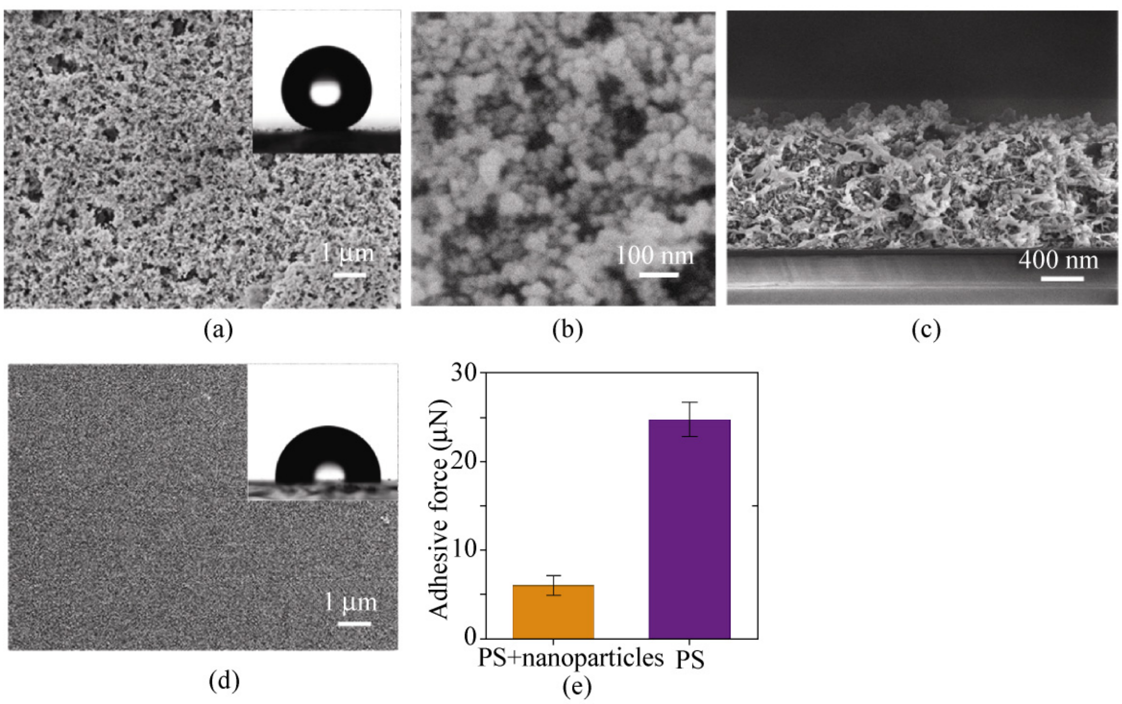


Figure S-1 (a) SEM images from the top-view and (c) cross-section of the nanoparticle-derived superhydrophobic composite coatings on glass plates. The inset image shows a water droplet on the film. (b) Top-view SEM image of the aggregated hydrophobic silica nanoparticles at high magnification. (d) Top-view SEM images of a pure PS film; the inset image shows a water droplet on the films. (e) The adhesive force of nanoparticle composite coatings (yellow) and pure PS coatings (purple)

Address correspondence to jianglei@iccas.ac.cn

the outside of the composite layer. Polystyrene (PS) glue acted as a binder to fix these nanoparticles firmly onto the plate. Such a hierarchical structure combined with low surface-free-energy silica nanoparticles endowed the pedestals with high water-repellent properties. The pure PS film had a water contact angle (CA) of only 93.7° ± 2.5° (Fig. S-1(d)), whereas the composite layer exhibited a much better water-repellent ability, with a CA of 158.7° ± 1.9°. Figure S-1(e) shows a comparison of adhesion between nanoparticle composite coatings and pure PS coatings. The adhesive force was measured by a high-sensitivity microelectromechanical balance system at 30% relative humidity. Pure PS coatings exhibited an adhesive force of 24.8 μN ± 1.9 μN while the composite coatings showed values as small as 6.0 μN ± 1.1 μN, indicating that the participation of nanoparticles not only contributed superhydrophobicity but also imparted ultra-low adhesive forces to the composite coatings.

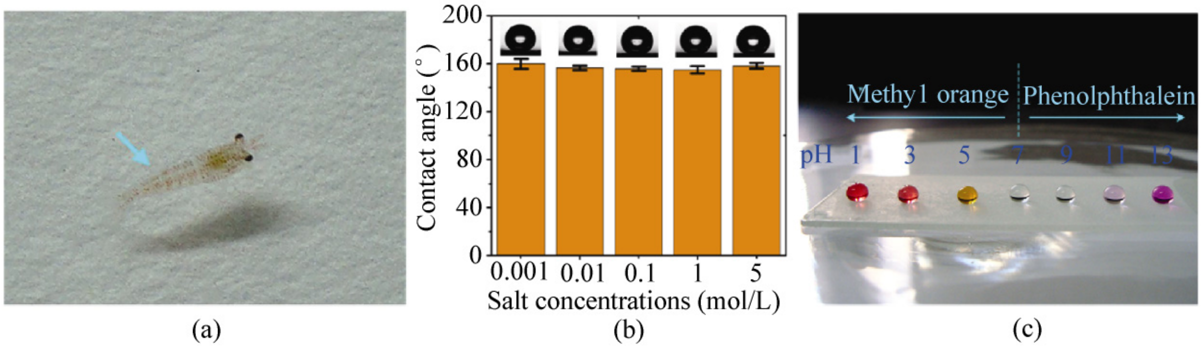


Figure S-2 (a) A *Caridina serrata* type shrimp swimming in a Petri dish full of water, showing its streamlined appearance (see the shadow). (b) The water CA on superhydrophobic pedestals of droplets containing NaCl solutions with different concentrations. (c) Droplets with different pH values being repelled by the coated pedestal. Low pH value was tailored by adding hydrochloric acid while high pH value was obtained by adding NaOH; methyl orange and phenolphthalein indicators, respectively, were added for easy observation

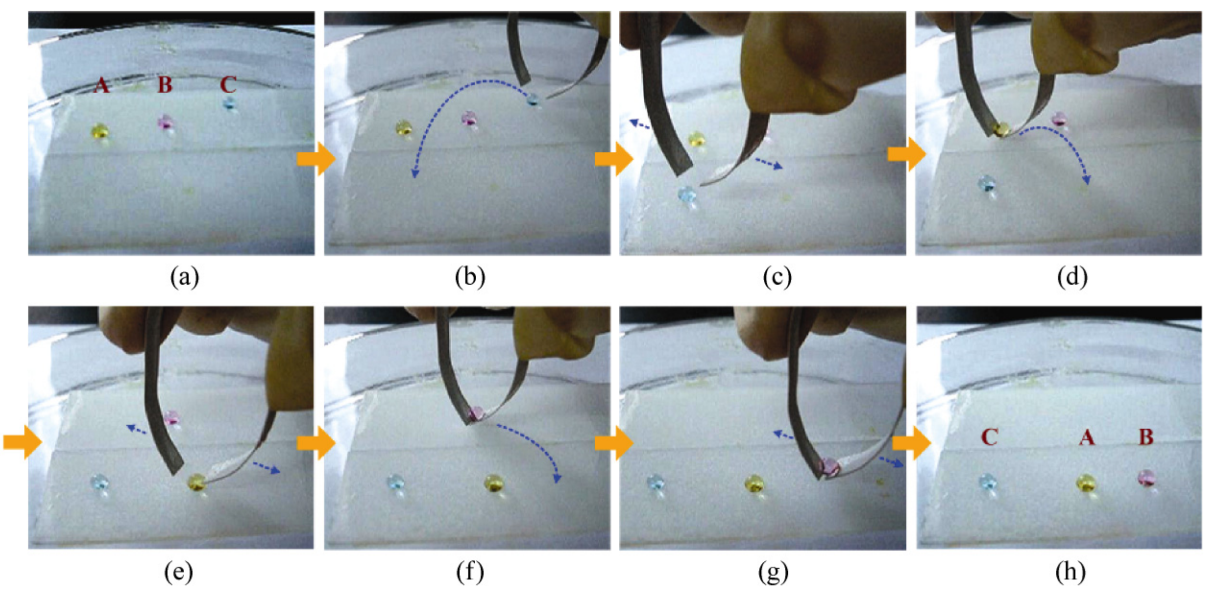


Figure S-3 Photographs of droplet sequencing on a superhydrophobic pedestal. Three water droplets, separately colored with yellow (1 mol/L $FeCl_3$), purple (0.1 mol/L KOH with 0.05 mol/L phenolphthalein solution), and blue (1 mol/L $CuCl_2$), could be gradually rearranged by a superhydrophobic clip

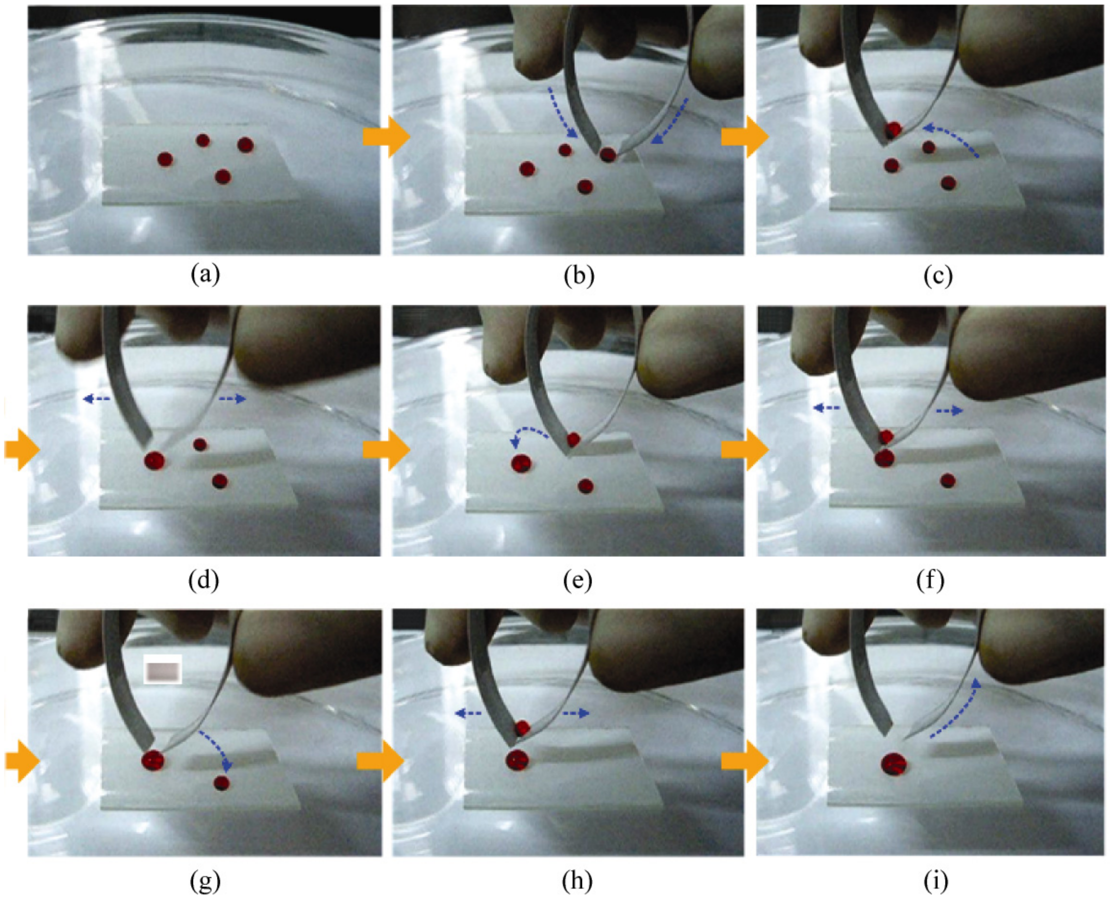


Figure S-4 Photographs of droplet collection on superhydrophobic pedestals. Four water droplets colored with 0.3 mol/L methyl orange could be collected and formed into a larger one

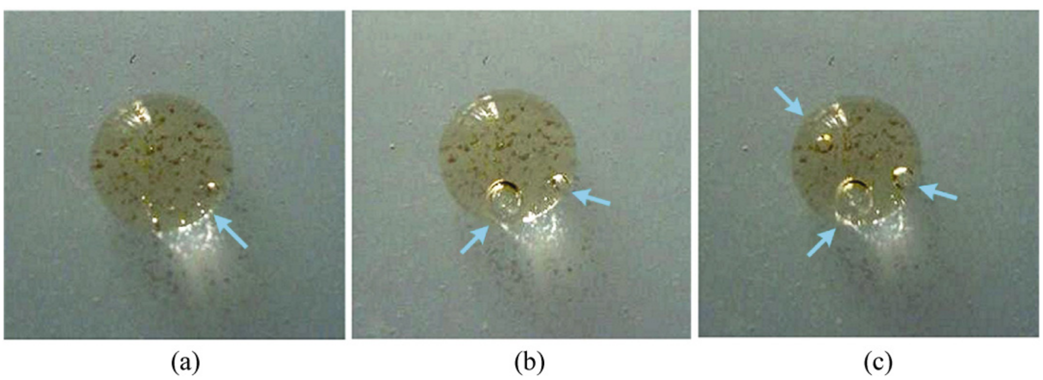


Figure S-5 Photographs of a decomposition reaction performed on a superhydrophobic pedestal. A droplet of 30% H_2O_2 aqueous solution (colored with a little methyl orange for easy observation) was carefully placed on the superhydrophobic plate and observed after exposure under a 60 W fluorescence lamp at distance of ca. 2 m. O_2 bubbles are clearly visible in the droplet

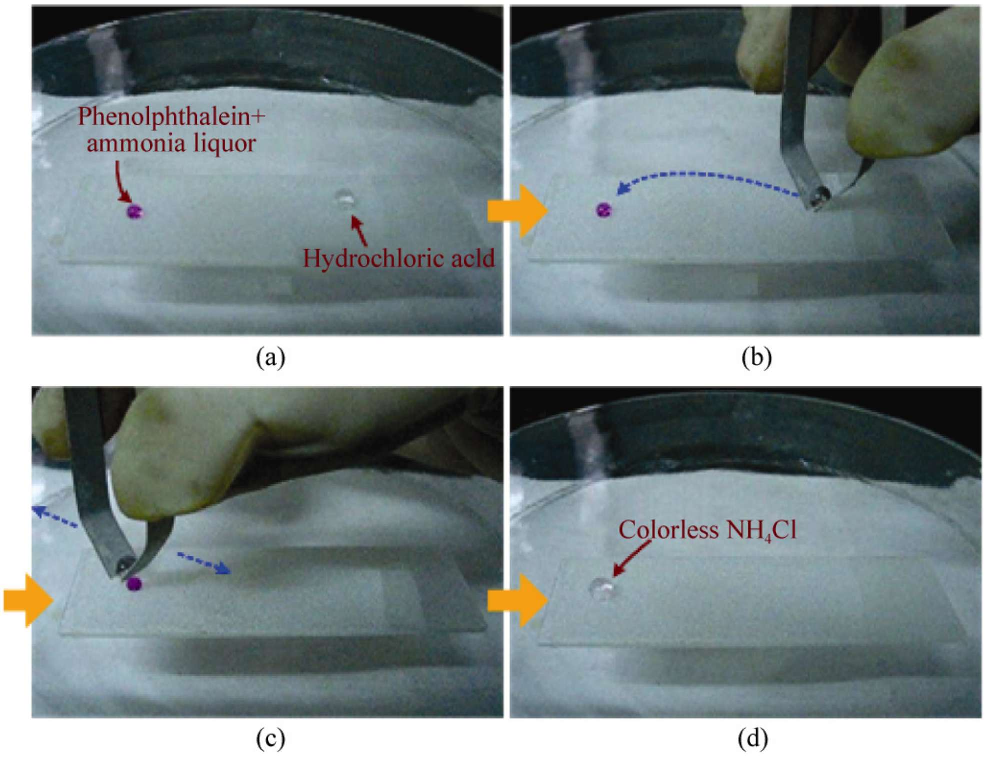


Figure S-6 Photographs of a neutralization reaction performed on a superhydrophobic pedestal. A colorless droplet of 1 mol/L hydrochloric acid was combined with a pink droplet of 1 mol/L ammonia liquor containing 0.05 mol/L phenolphthalein. The final droplet quickly changed from pink to colorless

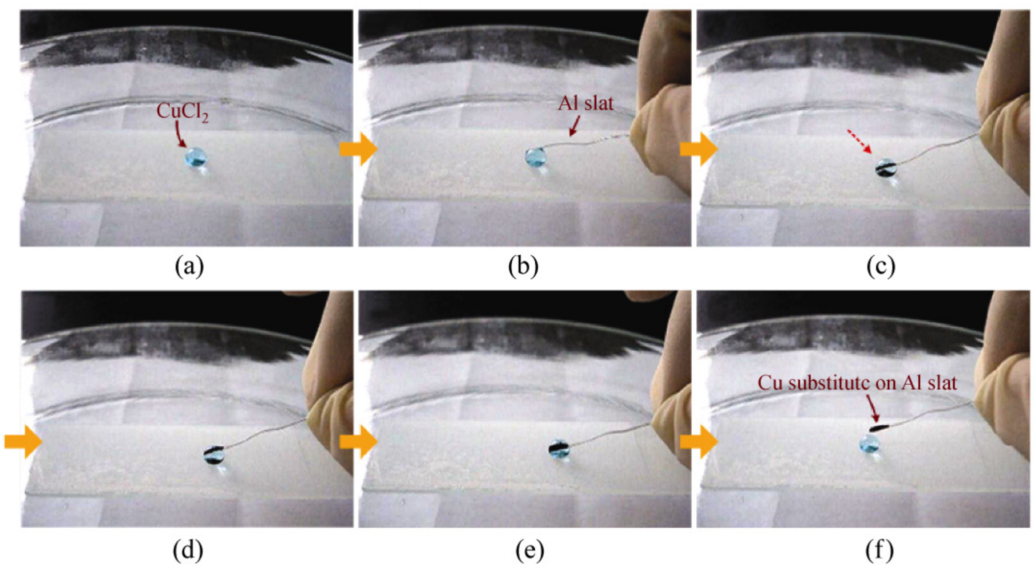


Figure S-7 Photographs of a displacement reaction performed on a superhydrophobic pedestal. An aluminium slat was inserted into a droplet of 1 mol/L $CuCl_2$ aqueous solution and dark particles of copper metal were subsequently found on the slat

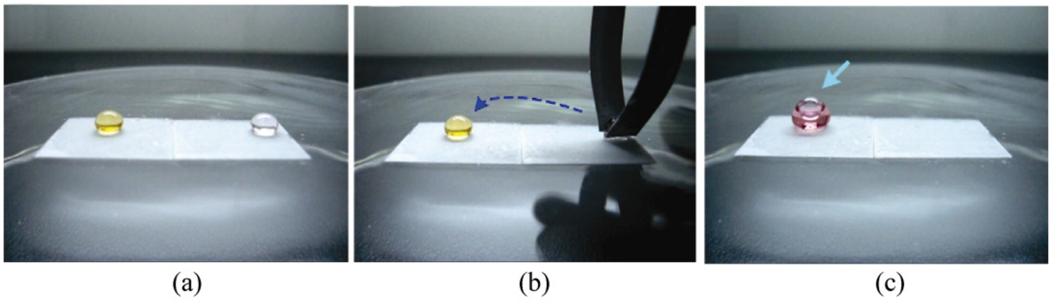
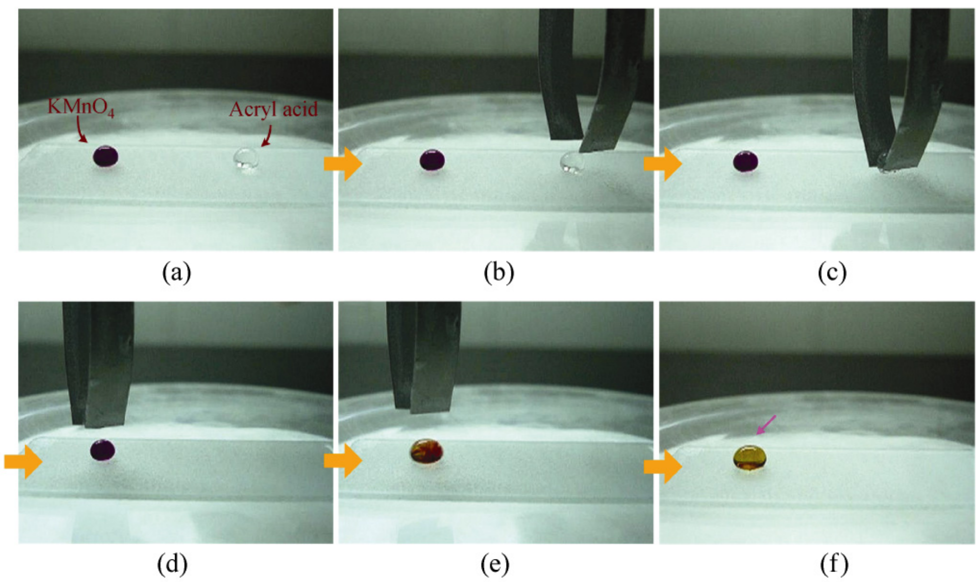


Figure S-8 A gas-forming metathesis reaction on a superhydrophobic pedestal was performed by adding a colorless droplet of 5 mol/L hydrochloric acid to a yellow droplet of 1 mol/L $NaHCO_3$ solution containing methyl orange; a large number of CO_2 bubbles were generated inside the droplet and finally broke out, as shown by the arrow



$$CH_2{=}CH{-}COOH + KMnO_4 \longrightarrow OHC{-}COOH + CO_2 + Mn^{2+}$$

Figure S-9 Photographs of an organic oxidation reaction performed on superhydrophobic pedestals. A purple droplet of 0.05 mol/L $KMnO_4$ solution was combined with a colorless droplet of 0.1 mol/L acrylic acid solution. The final droplet quickly changed from purple to yellow

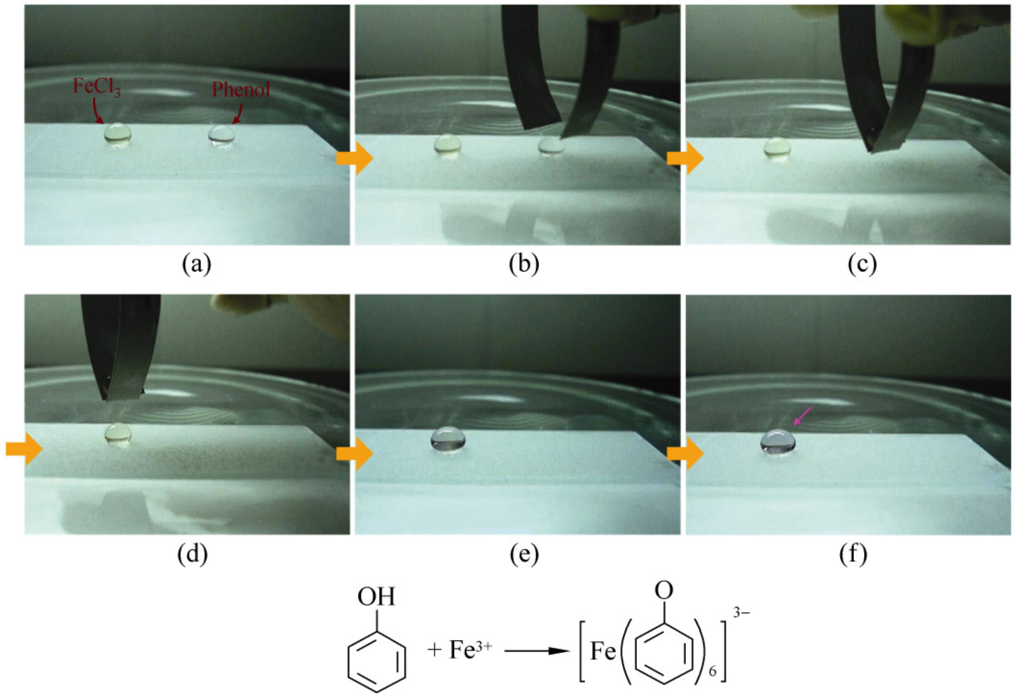


Figure S-10 Photographs of an organic color-forming reaction performed on a superhydrophobic pedestal. A yellow droplet of 0.05 mol/L $FeCl_3$ water was combined with a colorless droplet of 0.1 mol/L phenol solution. The final droplet quickly changed from yellow to pale purple