

Flexible Superwetable Tapes for On-Site Detection of Heavy Metals

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Supporting Video

SI Video 1. Simulated on-site detection of nickel ion standard solution (70 mg/L) using the superwetable tapes.

Materials and instruments

Hydrophobic silica powder (Degussa), 1H,1H,2H,2H-perfluorooctyltriethoxysilane, (FAS, Beijing Huaweiruike Chemical Technology Co., Ltd, China), ethanol ($\geq 99.8\%$, GR), double-adhesive tape (Beijing local store), photomask (Beijing Zhongjingkeyi Technology Co., Ltd, China), scraping ink bar (Hebei Zhongnuo Instrument Factory, China); copper sulfate (CuSO_4), nickel chloride hexahydrate ($\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$) and potassium chromate (K_2CrO_4) standard solution (Chinese Academy of Metrology), Chromium kit (Hangzhou Luheng biological Technology Co., Ltd, China), copper and nickel kit (Beijing Meihuayi Technology Co., Ltd, China). All chemicals were analytical-grade and used without any further purification.

Fabrication of superhydrophobic silica suspension.

The superhydrophobic silica suspension was prepared based on correction between fluoroalkylsilane (FAS) and hydrophobic silica particle.¹ 0.15 g hydrophobic silica, 0.2 g FAS were sequentially added into 12.4 ml absolute ethanol solution. The mixed solution was stirred at room temperature for 6 h and followed by ultrasonicated for 30 min to form a final superhydrophobic silica suspension.

Fabrication of flexible superwetable tapes.

Firstly, the tape was cut into small circle pieces and cleaned by O_2 plasma for 5min. Then, the as-prepared silica suspension was applied evenly on the release paper of the

tape as superhydrophobic layer by using a scraping ink bar. After ethanol volatilization, the tapes deposited with the FAS-modified-silica coating were etched by O₂ plasma at 100 W for 5 min through a customized photomask. The etched region became superhydrophilic. In contrast, the untreated area remained superhydrophobic. Thus we fabricated the flexible superwetable tapes.

Calibration of superwetable Cr (VI), Cu (II), Ni (II) colorimetric assay.

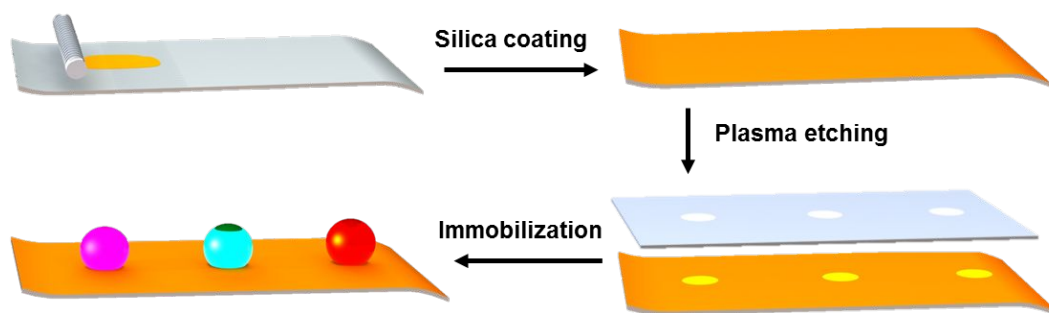
For the hexavalent chromium assay, the reagent mixture that contains 4 μL phosphate buffer saline solution dissolving 0.002 g diphenylcarbazide as color reagent was drop-cast on the superhydrophilic microwells. The reagent-microdroplet-based tapes were placed in ambient environment for active component immobilization onto the microwells after evaporation. Then 5 μL of potassium chromate standard solution of 0, 0.5, 1.0, 2.0, 4.0, 6.0 and 9.0 mg/L were added onto the functionalized microwell. Finally, a Nikon digital camera was used to record the chromogenic phenomenon, and the Imagine-J analysis software was used to read the grayscale value. Consequently, the corresponding calibration plot of colorimetric intensities vs the target calcium ion was obtained, which was linear with a correlation coefficient of 0.989 from 0.5 to 9.0 mg/L.

The copper sensing site was prepared by adding 1.5 μL of sodium tetraborate buffer solution and 3 μL bis(cyclohexanone)oxaldihydrazone following dried at ambient environment. 5 μL of copper standard solution with concentration ranging from 0, 1, 2, 3, 6, 8 to 12 mg/L were then dispensed on colorimetric reagent pre-modified superhydrophilic area. By using the same approach as chromium, the linear

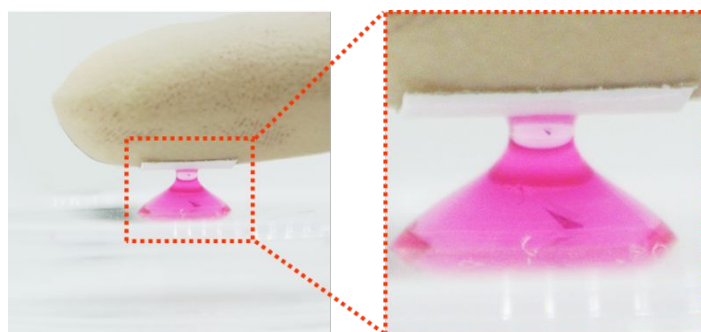
standardized curve of colorimetric intensities vs corresponding copper content was obtained with a correlation coefficient of 0.995 from 1 to 12 mg/L.

Similarly, for nickel analysis, 4 μ L ammonia-ammonium chloride buffer solution and 2 μ L dimethylglyoxime as color reagent were added onto microwells successively to produce sensing region after a total loss of solvent medium, followed by 4 μ L nickel standard solution of 0, 5, 10, 20, 30, 40 and 60 mg/L spotted onto the indicator-modified region. By using the same approach as chromium, the linear standardized curve of colorimetric intensities vs nickel abundance was obtained with a correlation coefficient of 0.974 from 5 to 40 mg/L.

Supporting Figures



SI Figure 1. Schematic of preparing superhydrophobic-superhydrophilic micropatterns on flexible tape substrate, followed by depositing silica coating and photomask-assisted plasma etching toward droplet-immobilized analysis application.



SI Figure 2. A thin neck phenomenon produced by competitive attraction between the pristine water and indicator-immobilized the superhydrophilic microwell during a dipping process.

Reference

1. Wang, P.; Chen, M.; Han, H.; Fan, X.; Liu, Q.; Wang, J., Transparent and abrasion-resistant superhydrophobic coating with robust self-cleaning function in either air or oil. *J. Mater. Chem. A* **2016**, *4*, 7869-7874.