# Supporting Information

# Superhydrophilic $Fe^{3+}$ Doped $TiO_2$ Films with Long-Lasting Antifogging Performance

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## Materials

Tetrabutyl titanate (≥99.0%) and sodium dodecyl sulfate (SDS, 92.5-100.5%) was purchased from Aladdin Industrial Corporation (Shanghai, China); nitric acid (65.0 ~ 68.0%), Iron nitrate nonahydrate ($Fe(NO_3)_3 \cdot 9H_2O$, ≥98.5% and absolute ethyl alcohol (≥95%) were obtained from Sinopharm Chemical Reagent Co., Ltd. (Beijing, China). Glass slides (75 × 25 × 1 $mm^3$) were consecutively sonicated in acetone and anhydrous ethanol for 20 min followed by blow-drying with nitrogen flow.

## Preparation of $Fe^{3+}$ Doped $TiO_2$ Films

Tetrabutyl titanate (17.02 mL, 0.05 mol) was dissolved in absolute ethyl alcohol (40 mL). After stirring magnetically for 30 minutes, deionized water (9 mL) with SDS (0.68 g) dissolved and absolute ethyl alcohol (25 mL) were mixed together and added into the solution dropwise, then add different amounts of ferric nitrate. The pH value of the solution was buffered close to 3 using nitric acid. After stirring magnetically for 2 hours, adding different amounts of $Fe(NO_3)_3 \cdot 9H_2O$. The molar ratios of Fe and Ti are 0, 0.5%, 1%, 2% and 3%. After ageing at room temperature overnight, transparent sols were obtained.

The $Fe^{3+}$ doped $TiO_2$ film was prepared by dip-coating method. The withdrawal speed was 120 mm $min^{-1}$ and the soaking time was 1 min. After coating, the samples were heat treated in a Muffle furnace. The temperature was elevated to 200 °C and kept for 30 min first. And then the above samples were annealed at 450 °C for 60 min. The heating rate was 3 °C $min^{-1}$.

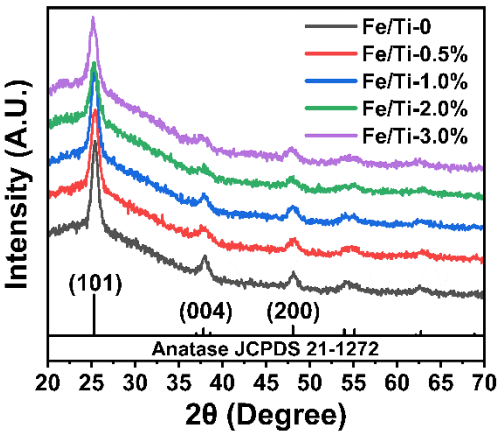


**Figure S1.** XRD patterns of different $Fe^{3+}$ doped $TiO_2$ films coated on the glass substrates.

**Antifogging Test**

The process of antifogging test is shown in **Video S1.** The sample in this video is Fe/Ti-1.0% after being placed in the dark for 60 days.

**Details of Recoverable Superhydrophilicity**

As shown in Figure 10, the light absorption of the film is mainly in the ultraviolet region. In the xenon lamp test, we adopt ISO 11341. The radiant flux was set to 60 W $m^{-2}$ between 300 and 400 nm and the irradiation time was one hour. The relationship between irradiance and exposure dose is as **Formula S1.**

$$H_e = \int E_e dt \quad (1)$$

The exposure dose during one hour in the xenon light box was calculated to be 0.216 MJ $m^{-2}$. Relevant research shows that the total amount of exposure dose in Hebei Province, China in 2011 was 237.44 MJ $m^{-2}$, which is converted to 0.65 MJ $m^{-2}$ per day. [S1] In Ningbo, Zhejiang Province of China, the annual average ultraviolet irradiance was 21.3 W $m^{-2}$ in 2015. [S2] In other words, ignoring the complex and changeable conditions of outdoor weather, about three-hour test of outdoor conditions are equivalent to one-hour xenon lamp test. Some researchers had calculated the total daily average ultraviolet radiation in Beijing, China from January 1979 to June 1996. [S3] They all exceed 0.4 MJ $m^{-2}$, which can meet the energy demand of the film to restore antifogging. It can be seen from the above that the film can restore hydrophilicity under natural conditions.

**References**

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