

Supplementary informations
RSC Advances

Preparation and Corrosion Resistance of Superhydrophobic Ni-Co-Al₂O₃ Coating on X100 Steel

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1. The microstructure of nano-Al₂O₃.

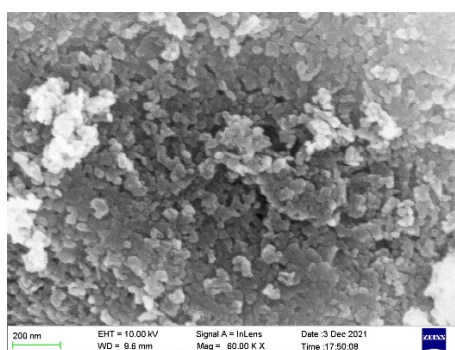


Fig.S1. Microscopic morphology of nano-Al₂O₃.

2. Element distribution and composition analysis.

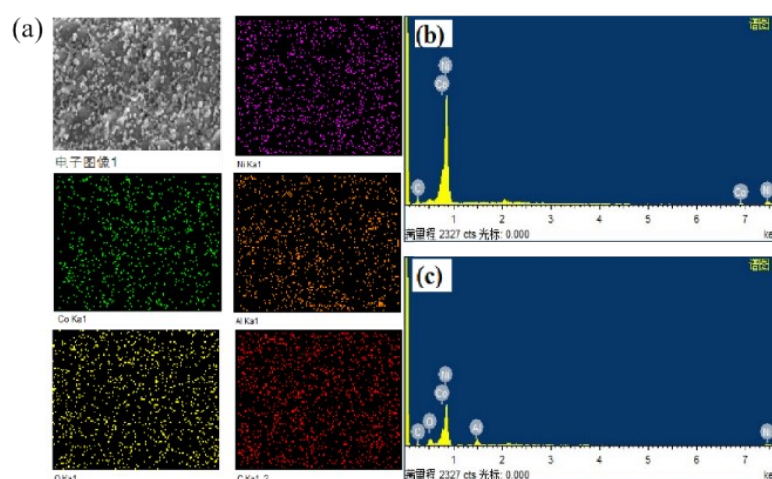


Fig.S2. (a) Elemental mapping of Ni-Co-15g/LAl₂O₃ composite coating; (b) and (c) are EDS spectra of Ni-Co coating and Ni-Co-15g/L Al₂O₃ composite coating.

Fig.S2(a) shows the elemental distribution of the composite coating when 15g·L⁻¹ nano-Al₂O₃ particles are added. The elements such as Ni, Co, O and Al are evenly distributed without obvious agglomeration. The results show that the Al₂O₃ particles are uniformly embedded in the Ni-Co metal matrix. The existence of C element may be the successful grafting of stearic acid on the

coating, which provides the possibility for the realization of superhydrophobicity.

Fig.S2(b) and (c) are the EDS spectra of Ni-Co coating and Ni-Co-15g·L⁻¹Al₂O₃, respectively. Ni, Co, Al, and O appear on the EDS spectrum, indicating that Al₂O₃ is co-deposited in the Ni-Co matrix. C appears in the spectrum, probably because stearic acid is adsorbed on the surface of the coating, which is consistent with the result of elemental mapping.

3. Superhydrophobicity mechanism (Adhesion analysis of superhydrophobic coatings)

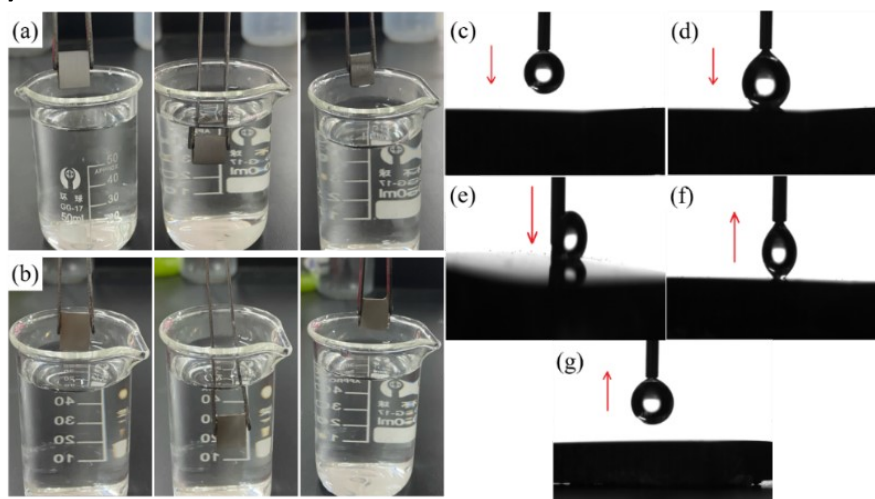


Fig.S3. Different samples the immersion and extraction process in water (a) X100 pipeline steel; (b) Ni-Co-Al₂O₃ superhydrophobic coating; (c-g) the low adhesion of water droplets on the surface of superhydrophobic coating.

As shown in Fig.S3(a), when the X100 steel is immersed in deionized water, a bright water layer similar to a silver mirror appeared on the surface, and the bare steel surface is wetted by water; When the prepared superhydrophobic coating is immersed in deionized water, as shown in Fig.S3(b), there is no water residue on the surface of the sample, and the surface has no obvious change and is not wetted. This phenomenon indicates that when the Ni-Co-Al₂O₃ superhydrophobic composite coating is in contact with water, the air cushion formed in the micro-nano layered structure combining cellular and papillary shapes prevents the sample from being wetted.

The adhesion of the superhydrophobic coatings is tested using a contact angle meter. Fig.S3(c-g) depicts the process of water droplets approaching and leaving the superhydrophobic coating surface. First, deionized water is suspended on the top of the dropper and moves down to make it close to the superhydrophobic surface. As can be seen from Fig.S3(d), due to the small wettability of the superhydrophobic surface, the contact area with the water droplet is relatively small, the water droplets touch across the surface. As shown in Fig.S3(e), the suspended water droplets are squeezed and deform after contacting the superhydrophobic surface, and rolls to one side, but the contact area with the sample dot not increase. When the dropper moves upwards slowly, the water droplets are deformed and elongate without breaking, as shown in Fig. S3(f), which proves that there is adhesion between the water droplets and the surface. When the dropper continued upward, the water droplets leave the coating freely without leaving any traces, and the water droplets keep their original shape. The experimental results indicate that the Ni-Co-Al₂O₃

superhydrophobic composite coating has very low adhesion, which is consistent with the Cassie-Baxter model and further indicates that the electrodeposited synthetic coating has excellent superhydrophobic properties.

4. Analysis of self-cleaning performance of different samples

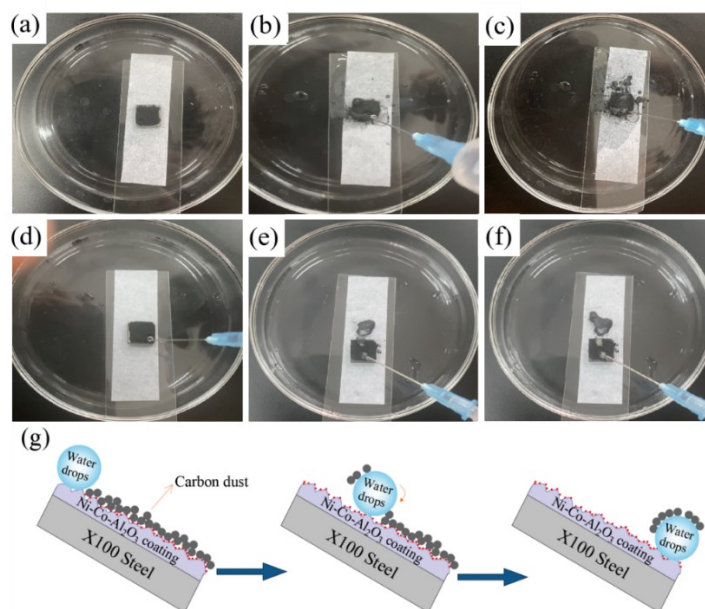


Fig.S4. Self-cleaning properties of different samples, (a-c) X100 pipeline steel; (d-f) Ni-Co-Al₂O₃ superhydrophobic composite coating, (g) Self-cleaning process mechanism.

First, fix the sample so that it forms a certain angle with the horizontal plane, drop deionized water on the sample covered with carbon powder, and observe the rolling of powder and droplets. It can be seen from Fig.S4(a-c) that the carbon powder on the surface of X100 steel cannot be taken away by water droplets, and the water droplets adhere to its surface to form a mixture. From Fig.S4(d-f), it can be seen that when the water droplets come into contact with the superhydrophobic surface, the droplets quickly roll off and carry away carbon powder on the surface, and finally, no contaminants remain on the surface of the superhydrophobic coating, indicating that the superhydrophobic coating has good self-cleaning properties and can protect the exposed coating from contamination.