Electronic Supplementary Information

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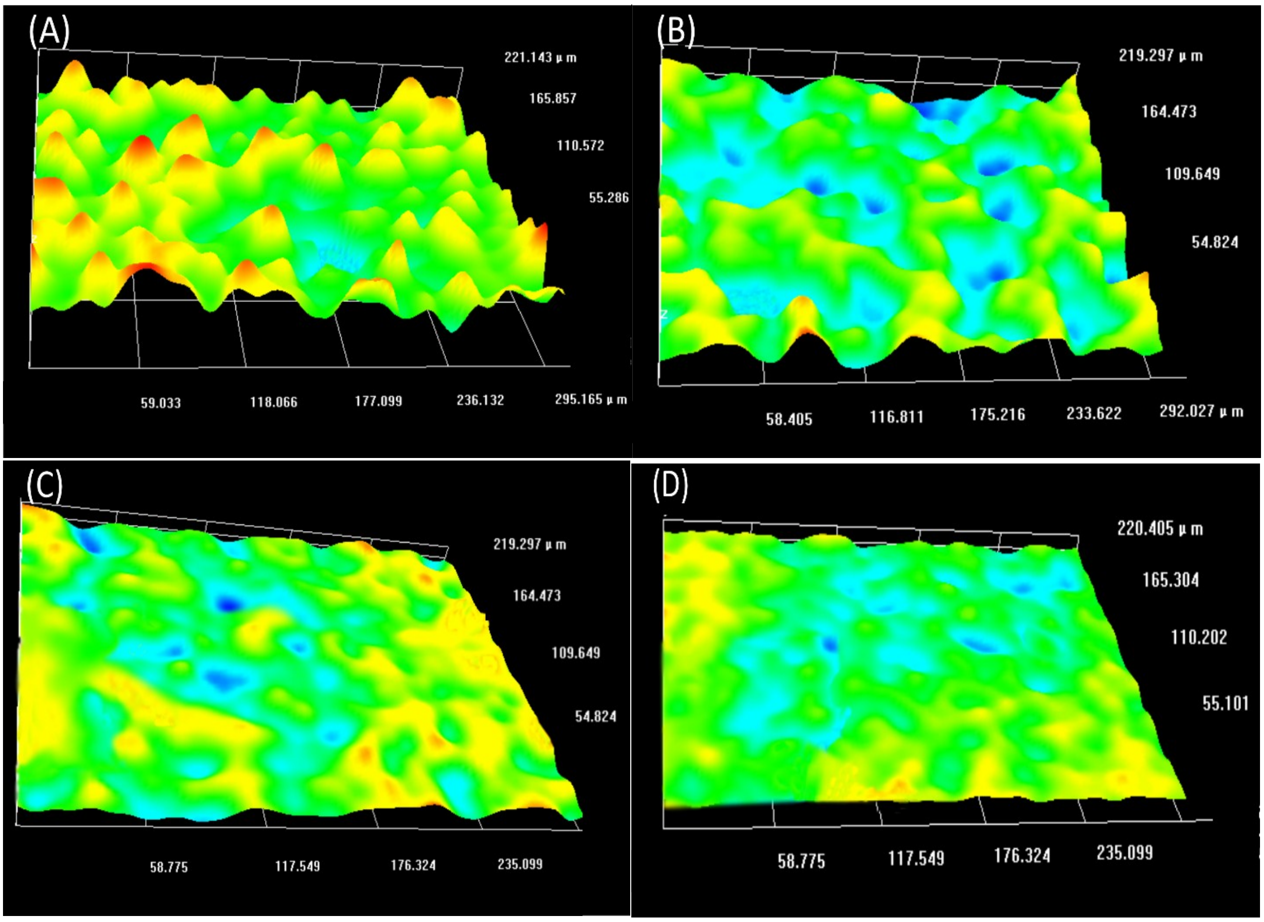
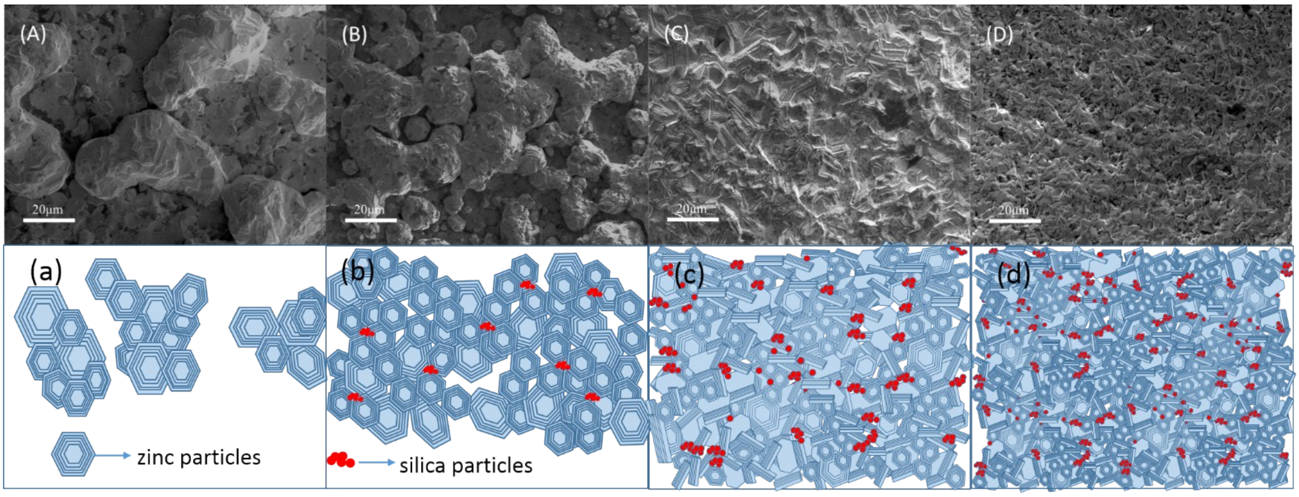
The surface roughness of the zinc coatings were observed by Hirox KH7700 Digital microscope. From the digital microscope images (S 1), it was obvious that the roughness of zinc coatings reduced with the increase of silica sols addition. In a comparison, the morphology of the surface coatings formed from the 15%-SSPB and 25%-SSPB were more uniform. As shown in S 1 (A), there were some large sized zinc particles on the zinc coating. S 1 (B) shows that silica sols reduced the size of the zinc particles. S 1 (C) and (D) show that when the silica sols content continued to increase, the zinc coatings became more uniform. The reduction of particle size was caused by the adsorption of silica nanoparticles, which has changed the electro deposition process of zinc coatings.



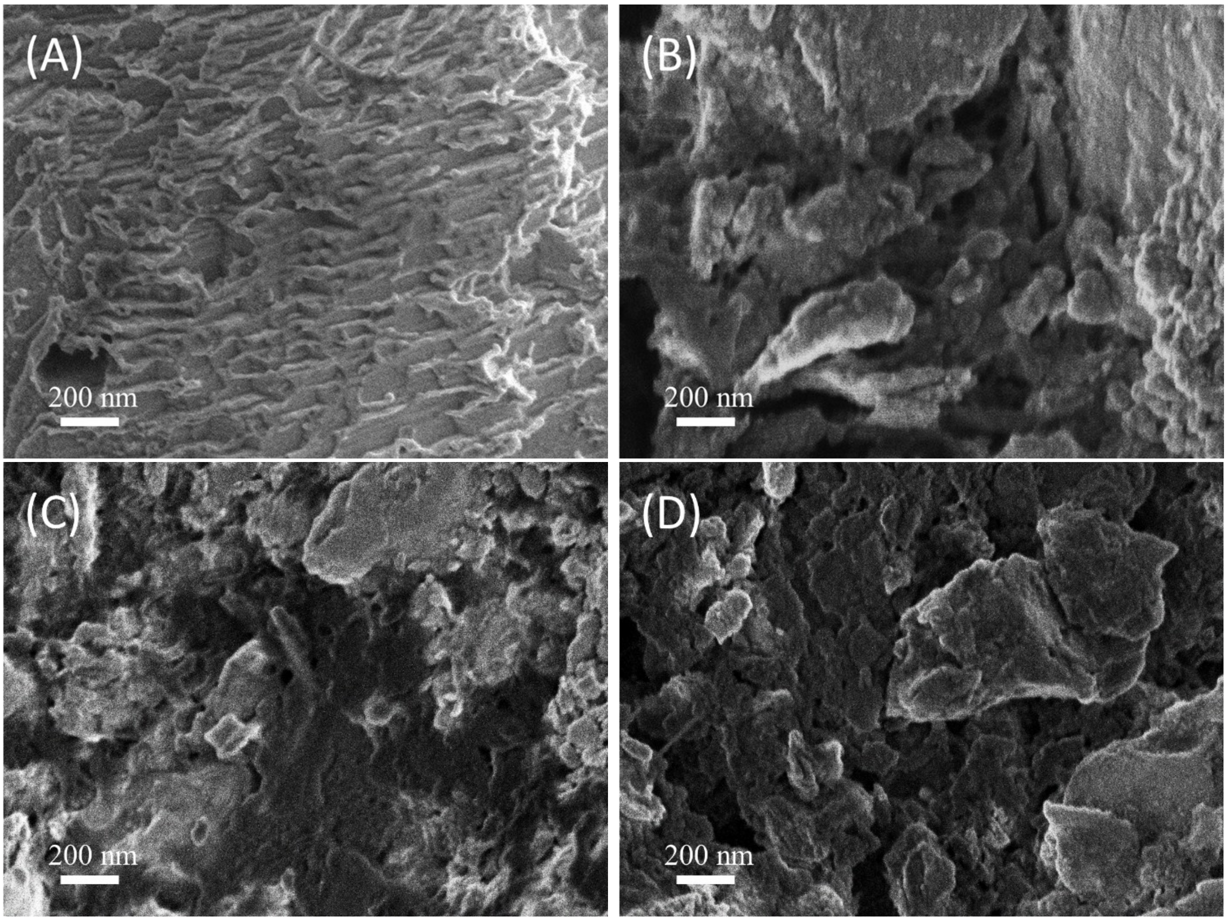
S1. Digital microscope images of (A) zinc coating from 0-SSPB, (B) zinc coating from 5%-SSPB, (C) zinc coating from 15%-SSPB, and (D) zinc coating from 25%-SSPB.

As shown in S 2 (A) and (a), when the zinc was deposited without silica sols, the nucleation point quantity was less while the particle size was larger. S 2 (b) shows that the adsorption of silica sols limited the growth of zinc particles and generated more nucleation site. It can be proved from S 2 (B). As shown in S 2 (C), the zinc coating covered the substrate uniformly when the silica sols content reached 15%. S 2 (c) shows the physical model that the adsorbed silica sols generated more nucleation site and changed the crystallization direction of zinc particles, which got extruded before they grow up to form the typical hexagon particles. The adsorbed silica nanoparticles may also be wrapped into the deposited coating in the growth process of zinc particles. When the silica sols content reached 25%, the size of zinc particles further decreased, which can been seen from S 2 (D) and (d). The adsorption of silica sols generated obvious effect on the electro deposition process.



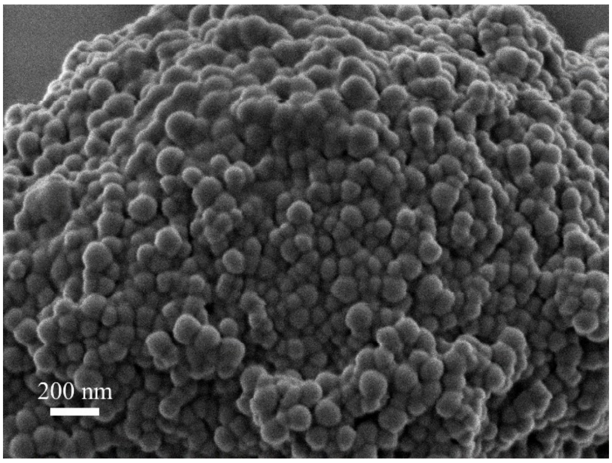
S2. Representative SEM and physical model images of (A) (a) the zinc coating obtained from the 0% SSPB, (B) (b) the zinc coating obtained from the 5% SSPB, (C) (c) the zinc coating obtained from the 15% SSPB, and (D) (d) the zinc coating obtained from the 25% SSPB.

S3 show some direct proof for the effect of silica sols on changing the zinc coating structure by comparing the cross section images of the zinc coating in the revised manuscript. As shown in S 3, the silica sols changed the structure of the zinc grains. In order to distinguish the silica particles from the zinc grain, the polished specimens was etched by ammonia and then ultrasonic cleaned in alcohol. The contrast of the silica phase was different from the zinc grains. Part of the zinc grain boundaries was also etched. S 3 (B) shows the combination of silica nanoparticles and zinc grains was not tight when the silica sols content was 5%. As shown in S 3 (C), when the silica sols content reached 15%, the zinc grains and the silica nanoparticles were tightly connected. There were also some embedded silica nanoparticles began to aggregate in the zinc coating. S 3 (D) shows the cross section of the zinc coating from 25 % SSPB. The aggregated silica particles generated some cracks, which might decrease corrosion resistance ability of the zinc coating. The effect of silica sols on changing the microstructure of zinc grains might be more direct by comparing the cross sections.



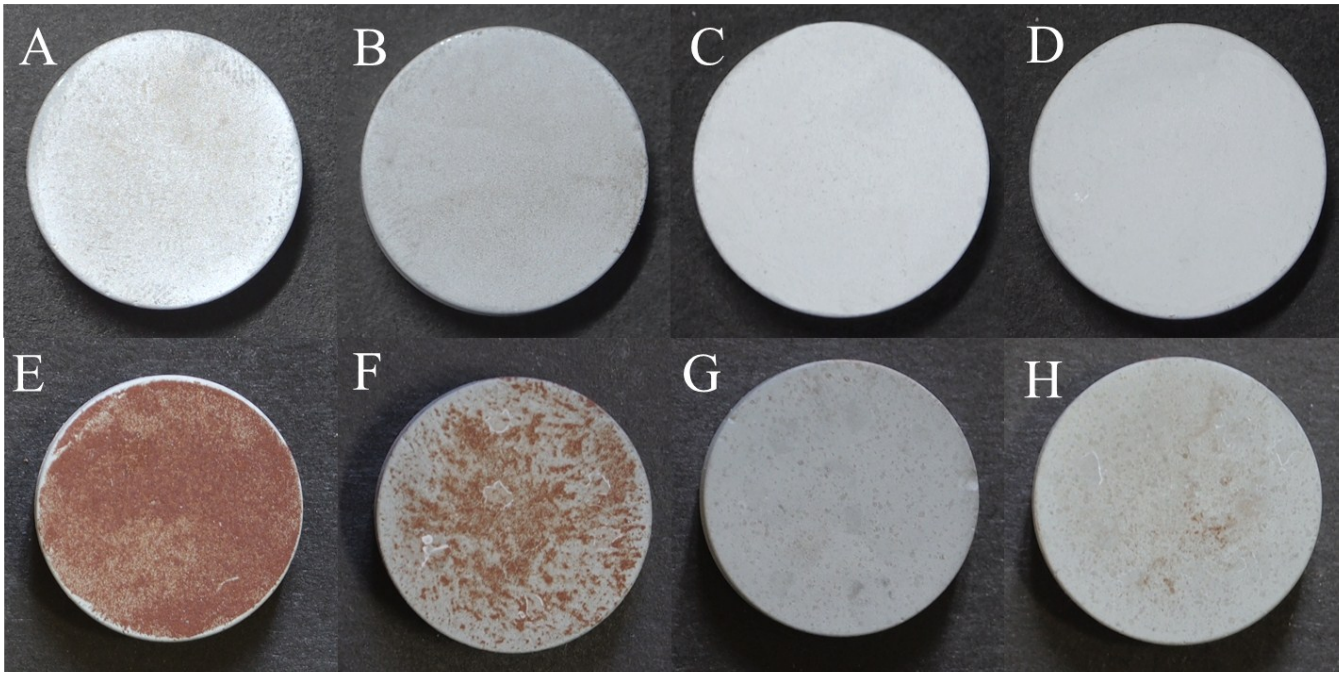
S 3. Representative SEM cross section images of (A) zinc coating from 0-SSPB, (B) zinc coating from 5%-SSPB, (C) zinc coating from 15%-SSPB and (D) zinc coating from 25%-SSPB

In order to evaluate the silica particles, the silica sols were deposited on bare NdFeB substrate using the dip-coating process at room temperature. S 4 shows the SEM image of silica nanoparticles. It is apparent that spherical silica nanoparticles with particle diameters below 150 nm can be prepared from the silica sols.



S 4. Silica particles SEM image

S 5 (A)-(D) show the images of freshly prepared zinc coated NdFeB from 0 SSPB, 5% SSPB, 15% SSPB and 25% SSPB. With the increase of silica sols content, the zinc coating shows better uniformity. S 5 (E)-(H) show the above samples after the explosion to open air for 200days. As shown in S 5 (E), the NdFeB coated by zinc coating suffered from serious corrosion. With the addition of silica in the zinc coating, the amount of corrosion products decreased obviously. The zinc coating from 15% SSPB and 25% SSPB protected the NdFeB better. When the silica sols content is in appropriate rage, the silica may help to improve the protection ability of zinc coating.



S 5. Images of freshly prepared zinc coated NdFeB from (A) 0-SSPB, (B) 5%-SSPB, (C) 15%-SSPB and (D) 25%-SSPB and images of zinc coated NdFeB from (E) 0-SSPB, (F) 5%-SSPB, (G) 15%-SSPB and (H) 25%-SSPB exposed to open air for 200 days