



Corrosion and Wear Resistance Aptitude Tests of SERMETEL Coatings under Aggressive Environments

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The Q235 steel is known for its good toughness and castability, making it easy to stamp and weld as a substrate. For the coating, SERMETEL water-based high-temperature coatings are used. One part of the first coating primer is applied using a closed coatings shot blasting method after surface cleaning 17-4PH stainless steel surfaces, while the other part is dry coated with closed coatings after the sandblasting process. The coatings were tested for service performance in various conditions, including dry hot air, neutral salt spray, sand abrasion, and heat/synthetic seawater salt spray/high humidity cycle tests. The dry hot air test results indicate that the SERMETEL coating is less thermally aggressive than the sandblasted SERMETEL coating, but neither can withstand prolonged high temperatures. After 3000 hours of neutral salt spray testing, the corrosion of the coatings became progressively worse. The coating is heavily corroded at the fork. The abrasion resistance of the SERMETEL coating and the sandblasted SERMETEL coating were 13.29 L/μm and 10.45 L/μm, respectively. The results of heat resistance/synthetic sea salt spray/high humidity

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cycling test for the two coatings under composite conditions show that after the compound alternating effects of sea salt spray, high temperature and high humidity, the two coatings did not show corrosion expansion or peeling off phenomenon at the scratching point. It shows that the two coatings have high corrosion resistance to seawater salt spray, high temperature and high humidity under composite cycling conditions. This paper has an important evidence for the future application of metal coating in seawater corrosion prevention.

Keywords: Stainless steel; coatings; aggressive environment; wear and corrosion resistance.

1. INTRODUCTION

The use of metal materials in aggressive environment on engineering equipment is increasing. However, these workpieces often suffer from serious corrosion in high temperature, high humidity, and high corrosion environments, which affects the operation and utilization of the entire engineering equipment [1-3]. The Q235 steel is known for its good toughness and castability, making it easy to stamp and weld as a substrate. For the coating, SERMETEL water-based high-temperature coatings are used. One part of the first coating primer is applied using a closed coatings shot blasting method after surface cleaning 17-4PH stainless steel surfaces, while the other part is dry coated with closed coatings after the sandblasting process. Considering the corrosion hazards of metal materials in the ambient environment and high-temperature oxidizing environment, for the application of special areas of the workpiece should be from the ambient environment corrosion environment to high-temperature oxidizing corrosive environment in the overall corrosion protection [4-6]. In practical applications, high strength steel workpieces require surface protection treatment to prevent serious corrosion and significant decrease in fatigue performance. This treatment is necessary to enhance the fatigue resistance, reliability, and service life of the workpieces [7]. At present, the surface protection technology of the metal substrate is mainly electroplating, thermal spraying carbide, enamel coating, anti-corrosion coatings [8-9]. Water-based aluminum-containing phosphate anti-corrosion coatings also known as metal ceramic anti-corrosion coatings, where ceramic refers to the coating binder for the phosphate ceramics, metal refers to the aluminum powder filler [10-12]. Water-based aluminum phosphate anti-corrosion coatings, when sprayed onto metal substrates and cured, form a metal ceramic coating. This coating provides effective corrosion protection for steel, titanium alloys, and other metals in high-temperature environments. It withstands 1000

hours of neutral salt spray testing and remains oxidation-resistant up to 600°C, making it suitable for aerospace and other metal corrosion protection applications [13-14]. Phosphate coatings have garnered significant interest among scientists and technologists due to their low raw material costs and excellent high-temperature performance. The inorganic phosphate binder, a key component of these coatings, has been extensively researched and applied across various surface protection treatments, promising a broad market potential [15-16]. This paper explores the primary anti-corrosion mechanisms of water-based aluminum phosphate coatings, focusing on shielding from corrosive media and chemical passivation. By spraying porous aluminum phosphate coatings onto a substrate surface over chromium-containing primer coatings, the risk of coating detachment due to differential coefficients of expansion between the coating and metal substrate is minimized. Additionally, chromium passivation within the primer paint enhances the formation of a protective passivation membrane on the metal substrate surface, further fortified by the curing of subsequent topcoat coatings [17]. At the same time, the chromium passivator in the primer coating passivates the surface of the metal substrate, forming a passivation film; the topcoat will form a layer of continuous dense aluminum-containing coating on the surface of the primer after curing, and the topcoat effectively seals off the pores of the primer coating, forming a dense aluminum-containing phosphate protective coating on the surface of the high-strength steel together with the primer coating [18-19]. Testing such as dry hot air, heat/synthetic seawater salt spray/high humidity cycling, neutral salt spray, and wear resistance has been conducted on SERMETEL water-based high-temperature coatings to enhance understanding of their corrosion and abrasion performance. This research is crucial for guiding and referencing the preparation and industrial application of phosphate coatings, offering significant insights into their broad applicability [20-21].

2. MATERIALS AND METHODS

2.1 Experimental Materials

The material used in the experiment is Q235B steel. Q235B steel is a commonly used low carbon steel, the yield strength is generally between 235-245MPa, with high strength and corrosion resistance, good welding performance and processing performance, widely used in construction, machinery manufacturing, highways and bridges and other fields, its chemical composition contains carbon, silicon, manganese, sulfur, phosphorus, etc., the specific composition is shown in the Table 1.

Table 1. Composition of experimental materials (%)

C	Si	Mn	S	P	Other
≤0.22	≤0.35	≤1.40	≤0.045	≤0.045	Fe

SERMETEL coating is made by brushing a high temperature resistant top paint composed of silicone, high temperature resistant fillers, auxiliaries and organic solvents. Main characteristics: Excellent heat resistance, capable of enduring prolonged exposure to high temperatures up to 200°C. It exhibits strong adhesion and offers resistance to moisture and oil. Moreover, it demonstrates superior weather resistance, making it suitable for direct application on high-temperature substrates up to 200°C. This coating is ideal for use on equipment such as boilers, engine casings, exhaust pipes, chimneys, and ovens, as well as on steel surfaces in pipelines with temperatures below 200°C.

The construction method is completed in two steps: spraying and brushing. High-pressure airless spraying is used. Adopt air spraying should pay attention to adjust the viscosity of the coating and air pressure. Diluent should not exceed 10%, otherwise it will affect the performance of the coating. It is used in pre-coating and small area coating, but the specified dry film thickness must be achieved. The method used in this test is to distribute the sandblasting and shot blasting treatment to the primer layer after drying of the sprayed primer, and then paint the top coat on the surface of the primer layer after sandblasting and shot blasting.

2.2 Pre-treatment of Specimens

Pre-cleaning of the test sample: The test sample is immersed in petroleum ether, gently wiped with

tweezers holding degreased cotton or medical gauze, thoroughly cleaned, and dried with hot air.

Polishing of the test sample: The uncoated surface of the test sample is progressively polished using 150-1000 grit sandpaper under dry conditions. The polishing direction follows parallel to the short edge, aligned with the direction of the line connecting the two holes.

Cleaning of the test sample: The polished sample is repeatedly rinsed with water to remove surface impurities and sand particles. Subsequently, it is alternately ultrasonically cleaned three times for 5 minutes each in anhydrous ethanol and acetone until all abrasives, sand particles, and other contaminants are removed. For samples coated with inorganic films, polishing is unnecessary; instead, they are simply rinsed thoroughly with water and then alternately ultrasonically cleaned three times for 5 minutes each in anhydrous ethanol and acetone.

Drying of the test sample: The cleaned test sample is dried with hot air and cooled to room temperature.

Preservation of test pieces: when the test cannot be done immediately, the test pieces should be put into a desiccator for preservation. However, the specimens kept for more than 24h should be re-polished.

3. CONTENT OF THE EXPERIMENT

3.1 Dry Hot Air Test

The specimens were kept at 600°C for 100h and 1000h, respectively, and then allowed to cool down to room temperature. After the test was completed, the damage, bubbles and discoloration were observed, and the structure, thickness and composition of the coatings were observed and analyzed by scanning electron microscopy, energy spectroscopy and X-ray diffraction to obtain the effects of the above exposure environments on the coatings.

3.2 Neutral Salt Spray Resistance Test

Neutral salt spray test according to GB/T1771 or GB/T10125, the cumulative duration of 3000h, and respectively at 500, 1000, 1500, 2000, 2500 and 3000h on the samples to observe whether the coating (scratching fork samples: the place of

the cut) is broken or seriously corroded, and the use of scanning electron microscopy, energy spectroscopy, X-ray diffraction on the structure of the coating Scanning electron microscopy, energy spectroscopy, X-ray diffraction were used to observe and analyze the coating structure, thickness, composition, corrosion products, etc., and to obtain the effects of the above exposure environment on the coating.

3.3 Thermal/Synthetic Seawater Salt Spray/High Humidity Cycle Resistance

The test piece was exposed to $35\pm 2^\circ\text{C}$ synthetic seawater (The PH value is 7.8 ± 0.2 .) spray for 1h, then immediately heated in an air-circulating oven at a temperature of 450°C for 2h, then cooled down to room temperature, and then exposed to a temperature of $45\pm 3^\circ\text{C}$ and a humidity of more than 95% for 20h as a cycle, and the test was carried out for 10 consecutive cycles. After the completion of the test, the coating (crossed samples: the place of cutting) was observed to see whether there was any breakage or serious corrosion, and scanning electron microscopy, energy spectrum and X-ray diffraction were used to observe and analyze the structure, thickness, composition and corrosion products of the coating, and to obtain the effect of the exposure environment on the coating as described above.

4. ANALYSIS OF RESULTS

4.1 Physical and Chemical Characterization of SERMETEL Coatings

Fig. 1a shows the surface morphology of the shot peening specimen coated with SERMETEL coating. As can be seen in the figure, the surface of the inorganic phosphate coating is relatively flat and the overall corrugated shape can be seen locally in a small number of microcracks. In addition, the surface of the coating is relatively flat under high magnification, and no cellular protrusions are seen.

Fig. 1b shows the surface morphology of sandblasted specimens coated with SERMETEL coating. As can be seen in the figure, the surface of the inorganic phosphate coating is relatively flat as a whole, and more micro cracks can be seen in the whole field of view, which are considered to be caused by the drying and

shrinkage of the coating as well as the temperature change during the coating preparation process, and the cracks can be seen in the local area as a sign of detachment. In addition, the surface of the coating is relatively flat under high magnification, and no cellular protrusions are seen.

Fig. 1c shows the cross-sectional morphology of the shot peening specimen coated with SERMETEL. It can be seen in the figure that the coating is thin, and the bonding with the substrate can be seen obvious boundaries, the coating is relatively loose inside, in the form of stacked particles, more internal pores.

Fig. 1d Cross-sectional morphology of sandblasted specimen coated with SERMETEL coating. It can be seen in the figure that the coating and the substrate are tightly bonded, and the coating is relatively dense inside, but the coating can be seen cracks and localized fragments, which should be thermal cracks caused by the influence of temperature during the preparation of the coating.

Fig. 1e and 1f show the EDX spectra of the surface and cross-section of the shot peening specimens coated with SERMETEL coatings, respectively. The spectra show that the chemical elements in the coating are mainly O, C, Cr, P, Mg and Al. From the content of metal elements, the content of Mg element is larger than that of Cr element and larger than that of Al element, and it is assumed that the original composition of the coating is a composite coating of Aluminum Chromium Phosphate and Magnesium Dihydrogen Phosphate.

4.2 Hot Air Drying Test

The muffle furnace was heated to 600°C , and after the temperature was stabilized, the shot-peened and sandblasted SERMETEL-coated 17-4PH stainless steel specimens were placed into the muffle furnace for 100h and 1000h, respectively, and then allowed to cool down to room temperature. Fig. 2a and b show the photographs of the surface condition of the SERMETEL-coated Q235 stainless steel specimens before and after shot peening and sandblasting for 100h and 1000h, respectively, in a dry hot air experiment at 600°C . At a certain temperature, the coating decomposed into P_2O_5 , Al_2O_3 , Cr_2O_3 and MgO composite coating.

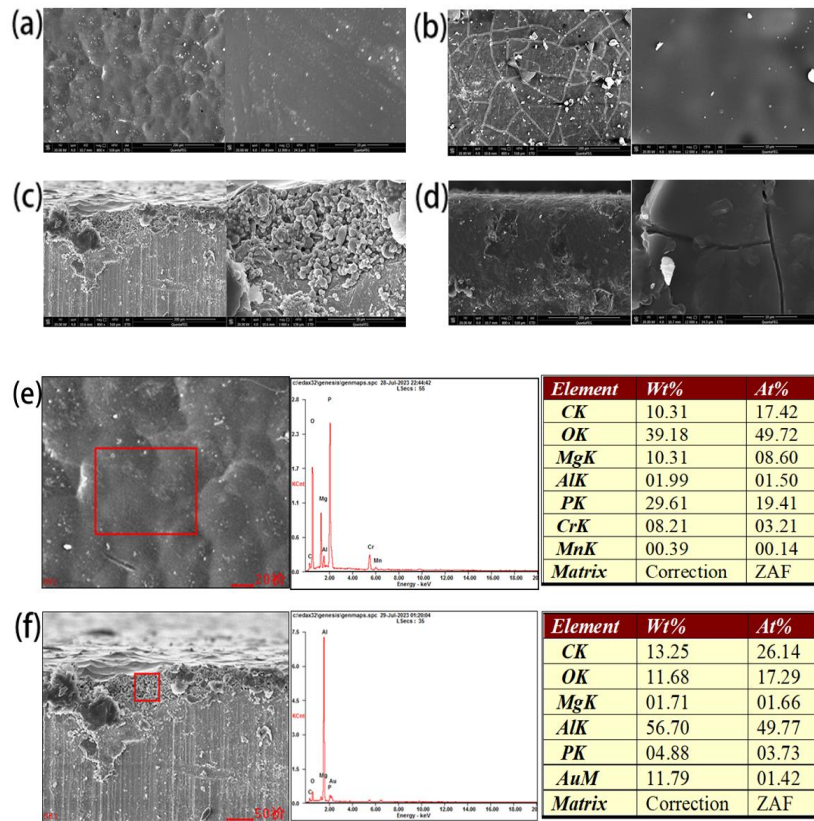


Fig. 1. Analysis of physical and chemical properties of SERMETEL coatings
 (a) SERMETEL coating shot peening treatment sample surface shape (b) The surface morphology of the sample was treated by sand blasting with SERMETEL coating (c) Section morphology of shot peening sample coated with SERMETEL coating (d) Section morphology of samples treated with SERMETEL coating by sandblasting (e) SERMETEL of EDX energy spectrum of coating sample surface (f) SERMETEL of EDX energy spectrum of coating sample cross section

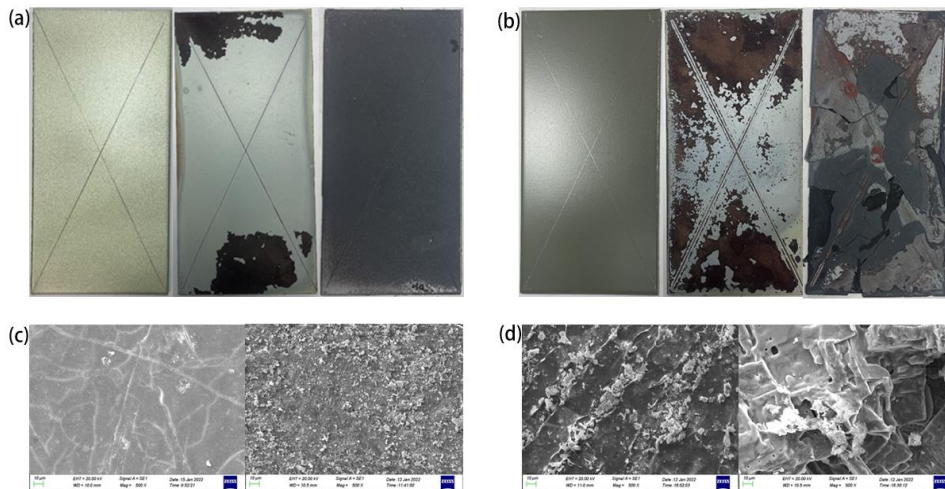


Fig. 2. (a)(b) Photographs of surface state of SERMETEL-coated Q235 stainless steel specimens pre-and post-shot peening and sand blasting before and after 100h and 1000h 600 ° C hot air drying experiments (c)(d) Surface Sem photographs of specimens coated with SERMETEL coating after continuous heating for 100 hours and 1000 hours in 600 ° C dry air by shot peening and sand blasting

Coated with SERMETEL coating shot peening specimens in 600 °C dry air heating for 100 hours, the specimen on the lower part of the upper part of the obvious signs of ablation loss of coating luster. 600 °C dry air heating for 1000 hours, the coating did not appear a large area of the phenomenon of shedding, but the color of the coating loses its luster to black, which indicates that a long time to maintain a temperature of 600 °C, the coating is still firmly bonded to the substrate, but not shedding. SERMETEL coating shot peening specimens, although more serious oxidative ablation phenomenon, but the coating and the substrate are still firmly combined, there is no phenomenon of shedding. Coated with SERMETEL coating sandblasted specimens at 600 °C in dry air continued to heat 100 hours, the coating appeared more serious oxidative ablation and accompanied by the phenomenon of coating shedding, to 1000 hours, the coating has been completely detached from the substrate and warped into fragments.

Fig. 2 c d shows the SEM photographs of the surface of the specimens coated with SERMETEL coatings by shot peening and sandblasting in dry air at 600°C for 100 h and 1000 h, respectively. Fig. c It can be seen that after 100 hours of continuous heating in dry air at 600°C, the surface of the specimen shows traces of coating fragmentation and detachment. When the time is extended to 1000 hours, the surface of the specimen is oxidized seriously, and the traces of coating are basically invisible, and the surface is covered with oxidized particles. Fig. d can be seen in the 600 °C dry air in the continuous heating for 100 hours, the specimen surface has traces of coating cracking and peeling off as well as serious oxidation. When the time is extended to 1000 hours, the coating on the surface of the specimen has all peeled off.

4.3 Neutral Salt Spray Resistance Test

Neutral salt spray resistance test according to GB/T1771 or GB/T10125 neutral salt spray test, the cumulative duration of 3000h, and respectively in 500, 1000, 1500, 2000, 2500 and 3000h on the sample to observe the coating (scratch the fork sample: the place where the cut) whether there is a breakage or serious corrosion, to obtain the impact of the above exposure to the environment of the coating.

Fig. 3a. shows macroscopic photographs of the surface of the 17-4PH stainless steel specimens prior to the neutral salt spray test and after being

kept shot peened with the SERMETEL coating for 1000 h, 2000 h and 3000 h, respectively. After 1000 hours of neutral salt spray test, there are more rust stains on the surface of the specimen, especially at the edge part of the specimen and at the scratching point, and the corrosion is serious and extends to both sides of the scratching point. The surface of the specimen is partly covered by reddish-brown rust. When the neutral salt spray test reaches 2000 hours, the surface of the specimen is completely covered by red-brown rust. When the neutral salt spray test reaches 3000 hours, a large area of the surface of the test specimen appears to be peeling off the coating.

Fig. 3b shows the macroscopic photographs of the surface of 17-4PH stainless steel specimens before the neutral salt spray test and after keeping the SERMETEL coating sandblasted for 1000, 2000 and 3000 hours respectively. After 1000 hours of neutral salt spray test, there are more rust stains on the surface of the specimen, and the corrosion is more serious at the edge part of the specimen. When the neutral salt spray test reaches 2000 hours, the surface corrosion of the specimen is more serious, and the phenomenon of coating peeling and bulging appears. When the neutral salt spray test reaches 3000 hours, the phenomenon of coating peeling and bulging on the surface of the specimen is more serious.

Fig. 3c shows the metallographic photographs of the surface of Q235 stainless steel specimens treated with shot peening of SERMETEL coating in neutral salt spray test 1000h 2000h 3000h respectively. After a long period of neutral salt spray test, the surface of the specimen was covered with reddish-brown rust stains after 1000 hours, and the coating was still visible underneath the rust stains, the surface of the specimen was covered with reddish-brown rust stains, and the coating was seriously puckered and cracked after 2000 hours, and the surface of the specimen was washed repeatedly after 3000 hours, and the coating was lost, and the metal substrate was exposed.

Fig. 3d shows the metallographic photographs of the surface of Q235 stainless steel specimens treated with sandblasted SERMETEL coatings in the neutral salt spray test 1000h 2000h 3000h respectively. after 1000h the surface of the specimen is covered with reddish-brown rust stains, after 2000h the surface of the specimen is covered with reddish-brown rust stains, and

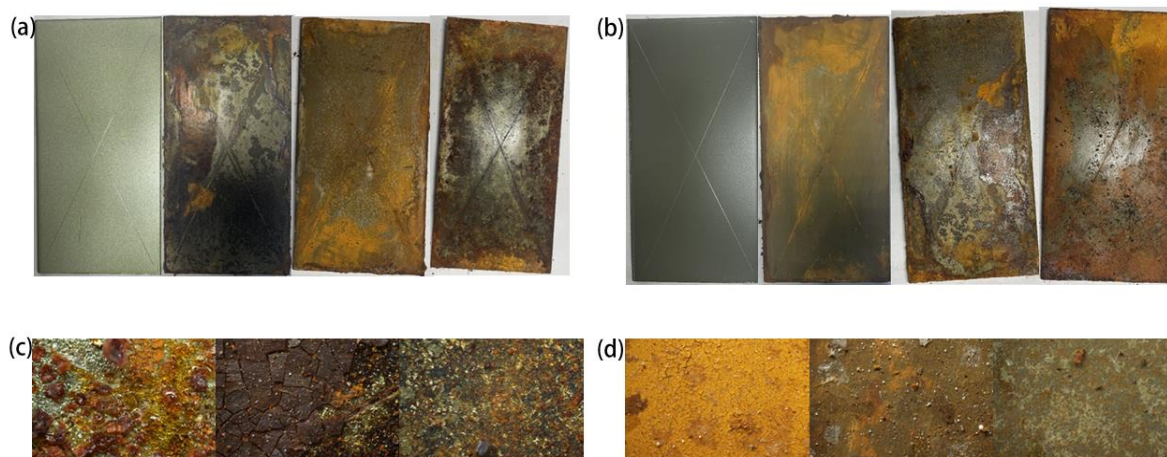


Fig. 3. (a)(b) Macroscopic photographs of the surface of 17-4PH stainless steel specimens before neutral salt spray test and after 1000 hours, 2000 hours and 3000 hours, respectively, shot peening and sandblasting of SERMETEL coating (c)(d) Neutral salt spray test 1000h 2000h 3000h SERMETEL coating shot peening and sand blasting Q235 stainless steel samples surface metallographic photographs

white salt deposition particles can be seen. after 3000h, the coating is lost and the substrate is exposed.

It is mainly that the conductive salt solution seeps into the metal and the electrochemical reaction takes place, which forms the "Low potential metal-electrolyte solution-high potential impurity" microbattery system, and the electron transfer occurs, the metal used as the anode dissolves, forming new compounds called etchants. The main factors affecting corrosion are water, oxygen and ions. Chloride ion plays an important role in the process of salt spray corrosion, it has a strong ability to penetrate the metal oxide layer into the metal and destroy the passive state of the metal, easily adsorbed on the metal surface, to replace the protective metal oxide layer of oxygen, the insoluble oxide into soluble chloride, so that the metal is destroyed.

4.4 Heat/Synthetic Seawater Salt Spray / High Humidity Cycle Resistance

SERMETEL coated shot and sandblasted Q235 stainless steel specimens in a 35°C salt spray box synthetic seawater spray 1h, followed by the specimen is immediately transferred to the temperature of 450°C in the air circulation oven heated for 2h, and then cooled to room temperature, and then in the temperature of 45°C,

humidity 95% of humidity in the humidified hot box to maintain 20h, the above process for the heat-resistant / synthetic seawater spray / high humidity The above process is heat resistant/synthetic seawater salt spray/high humidity for 1 test cycle, and 10 consecutive cycles are carried out.

Fig. 4a is a macroscopic photo of the surface of Q235 stainless steel specimens coated with SERMETEL coating shot peening before and after the heat-resistant/synthetic seawater salt spray/high humidity cycle test. It can be seen that after the salt spray, high temperature, high humidity compound alternating action, although the metal at the cross has oxidized darker, but the coating at the cross did not see corrosion expansion or shedding phenomenon, corrosion did not extend to the coating and the coating and the metal substrate interface, the coating is only the edge of the corrosion traces, the color of the coating has not changed, but the loss of surface luster. This shows that SERMETEL coating shot peening for seawater salt spray, high temperature, high humidity compound cycle conditions of corrosion resistance is high.

Fig. 4b is a macroscopic photograph of the surface of Q235 stainless steel specimens coated with SERMETEL coating sandblasted before and after the heat-resistant/synthetic

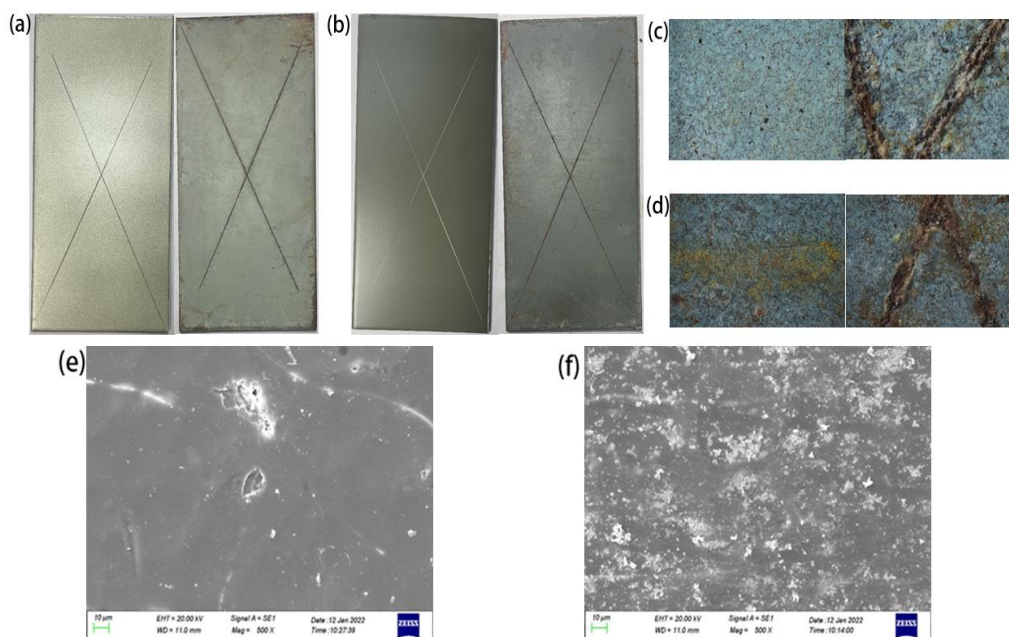


Fig. 4. (a)(b) Macroscopic photographs of the surface of Q235 stainless steel specimens coated with SERMETEL coating shot peening and sand blasting before and after thermal/synthetic sea water salt spray/high humidity cycling tests (c)(d) Surface metallography of Q235 stainless steel coated with SERMETEL coating after 10 cycles of heat-resistant/synthetic seawater salt spray/high humidity cycling (e)(f) Scanning electron microscopy (SEM) of SERMETEL coating after thermal/synthetic seawater salt spray/high humidity cycling test

seawater salt spray/high humidity cycling test, and the surface corrosion situation is the same as that of Q235 stainless steel specimens coated with SERMETEL coating shot peened and sandblasted.

Fig. 4c and Fig. 4d show the surface metallographic photographs of Q235 stainless steel specimens coated with SERMETEL coatings by shot peening and sandblasting after 10 cycles of 1h synthetic seawater spraying in a salt spray chamber at 35°C, 2h heating in an air-circulating oven at a temperature of 450°C, and 20h of heat-resistant/ synthetic seawater salt spraying/high-humidity cycling in a humid chamber with a temperature of 45°C and a humidity of 95%, respectively. In the picture, it can be seen that the surface of the specimen has more corrosion phenomenon, but no coating peeling off. There is obvious corrosion at the crossing but there is no shedding of coating based on the crossing area, which indicates that the coating and the substrate have a good bonding strength, and although there is corrosion on the surface after cycling under the three conditions, it is obvious that the corrosion fails to

reduce the bonding strength between the coating and the substrate. Salt deposition on the surface of the coating was observed, especially at the scoring area, because the scoring area was rough and the salt in the synthetic seawater was easy to be precipitated and deposited in the grooves.

Fig. 4e f shows the SEM morphology of shot peening and sandblasting coated SERMETEL coatings after heat/ synthetic seawater salt spray/ high humidity cycling tests, respectively. It can be seen that the surface of the shot peening specimen has the phenomenon of coating surface crack expansion and fragmentation. The sandblasted specimen has salt dissolution deposits on the surface.

5. CONCLUSION

Inorganic phosphate-based composite coating is an important development direction in the surface protection coating, based on its own radiation resistance, high temperature resistance, adapt to the space environment, as well as weathering and other unique properties, has received more and more attention, in the field of

surface protection technology shows a very broad application prospects. However, with the progress of human science and technology and the exploration of unknown fields, especially the rapid development of modern aerospace, ships, weapons and nuclear technology and other high-tech equipment, the relevant parts are faced with extremely complex service conditions (such as high and low temperature cycling, space environment, nuclear radiation environment, strong particle flow environment, multi-phase or special liquid media environment, etc.), which is suitable for the extremely harsh working conditions of the surface protective coatings put forward more stringent application requirements. This puts forward more stringent application requirements for surface protective coatings applicable to extremely harsh working conditions, and is also a great challenge for the development and expansion of the application of inorganic phosphate-based composite coatings. At present, the research and application of inorganic phosphate-based composite coatings in the field of surface protection still lacks a complete theoretical basis, on its own there are many inherent defects, such as brittleness, poor adhesion, and not wear-resistant, etc., which need to be solved urgently. Therefore, it is necessary to focus on the composition of the coating, structural design, structure-effect relationship and multi-factor coupling, coating materials, multi-dimensional, multi-phase, multi-scale surface interface effects and evolution of key common scientific issues, such as the design of the basic resin modification, the coating surface interface fine structure design and control of the control of the preparation of functional filler synergistic effect of the advanced design methodology and preparation technology and other aspects of the research. The project was centered around performing dry heat resistance tests, as well as heat, synthetic seawater salt spray, and high humidity cycling tests on SERMETEL coatings treated with shot blasting and sandblasting, respectively. By thoroughly addressing current research gaps, the study aimed to improve understanding of the corrosion and abrasion resistance properties of these coatings. This research holds significant importance as it provides essential guidance and references for the preparation and industrial application of phosphate coatings, which are extensively utilized. Specific experimental conclusions are outlined as follows:

(1) After subjecting the SERMETEL-coated sample treated with shot blasting to 100

hours of continuous heating at 600°C in dry air, noticeable signs of erosion and loss of coating gloss appeared on both upper and lower parts. Despite the coating's color shifting to black due to severe oxidation, there was no widespread detachment observed, indicating strong adhesion between the coating and substrate. In contrast, the SERMETEL-coated sample treated with sandblasting exhibited more severe oxidation and significant coating detachment under the same conditions. This comparison highlights that the sandblasted SERMETEL-coated sample exhibits poorer durability in prolonged high-temperature environments compared to its shot-blasted counterpart.

- (2) After 1000 hours of neutral salt spray test, there are more rust stains on the surface of the SERMETEL coated shot peening specimen, especially on the edge of the specimen and at the fork, and the rust is serious, and the corrosion expands to both sides of the fork. The surface of the specimen was partially covered with reddish-brown rust. When the neutral salt spray test reaches 2000 hours, the surface of the specimen is completely covered by red-brown rust. When the neutral salt spray test reaches 3,000 hours, a large area of the surface of the specimen appears to be peeling off the coating. After 1000 hours of neutral salt spray test, the surface of SERMETEL coated sandblasted specimen has more rust stains, and the corrosion is more serious at the edge of the specimen. When the neutral salt spray test reaches 2000 hours, the surface corrosion of the specimen is more serious, and the phenomenon of coating peeling and bulging occurs. When the neutral salt spray test reaches 3000 hours, the phenomenon of coating peeling and bulging on the specimen surface is more serious.
- (3) Following heat, synthetic seawater salt spray, and high humidity cycling tests, although the scratched metal displayed deeper oxidation discoloration, the coating showed no signs of corrosion expansion or detachment at the scratch site. Corrosion did not propagate into the coating or its interface with the metal substrate; only minor corrosion traces were evident at the coating edges, with no change in color but a loss of surface gloss. This underscores that both shot blasting and sandblasting

treatments of SERMETEL coatings offer robust corrosion resistance under the combined conditions of seawater salt spray, elevated temperatures, and humidity cycling.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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