

Study of the Technology Preventing the deformation area of the Hot -Dip Zn -Al Galvanizing steel Blackening

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Abstract. In order to prevent the deformation area of the hot -dip Zn -Al Galvanizing extra deep drawing steel blackening during the drawing process, the microstructure and composition of the blackening area was researched by SEM and EDS. The blackening during the drawing process was caused by Zn -Al coating corrosion after the damage of passive film. And the effective measures that the surface passive film on Zn -Al coating had self-lubrication and the friction factor of the surface below 0.2 to prevent the blackened was determined. Then a self-lubricating hot -dip Zn -Al Galvanizing extra deep drawing steel was developed. After the application of Technology about the self-lubricating hot -dip Zn -Al Galvanizing, the blackening did not appear again.

1. Introduction

The hot -dip Zn -Al Galvanizing steel is one of the varieties with high value-added in the cold-rolled sheet products, which has some excellent performances such as corrosion resistance and good appearance. It is widely used in construction, transportation and automobile manufacturing industry. In recent years, for environmental protection and cost reduction, the home appliance user put forward the requirement^[1-2]that the hot -dip Zn -Al Galvanizing steel instead of the sprayed GI steel in the home appliance parts such as the chassis of air conditioner, the chassis of the washing machine and the backplane of television, due to the excellent quality characteristics of the hot -dip Zn -Al Galvanizing steel. The shape of the home appliance parts are more and more complex, normally it need to use the process of deep drawing. But because of the coating containing contains a high proportion of Al, the hot -dip Zn -Al Galvanizing steel appear a certain degree of black after the drawing process in the part fillet, flanging area and some surface, as shown in Fig. 1. The blackening seriously affect the appearance of parts and the corrosion resistance of the hot -dip Zn -Al Galvanizing steel.



Fig. 1 The blackening phenomenon during the drawing process



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In order to improve the formability of the hot -dip Zn -Al Galvanizing steel, a lot of researches have been carried out[3 –5]. A number of foreign suppliers of chemicals developed the lubrication-enhanced fingerprint resistant passivating agent by adding lubricating additives. But this kind passivation sheet still appears blackening or plow marks on the surface after deep drawing forming that significantly reduce the subsequent corrosion resistance of materials. In present study, the causes of the blackening of the hot -dip Zn -Al Galvanizing steel were analyzed, and the effective measures to prevent the drawing blackening were determined, then a self-lubricating hot -dip Zn -Al Galvanizing extra deep drawing steel was developed.

2. Experimental

2.1. Passivation of the hot -dip Zn -Al Galvanizing steel

The hot -dip Zn -Al Galvanizing steel for test was the sheet of DX54D+AZ produced by Pangang Group Co., Ltd., with the size of 0.7mm*1000mm and the coating weight of 150g/m². In the production line, the common chrome-free fingerprint resistant liquid called A and the chrome-free self-lubrication liquid called B. In the present study, this two kinds of liquids evenly coated on the surface of the hot -dip Zn -Al Galvanizing steel after skin rolling, then drying the film.

2.2. The deep drawing and forming

The passivated hot -dip Zn -Al Galvanizing extra deep drawing steel A, B, DB and BG, in which DB and BG were taken as benchmark parts made by international well-known companies. All these sheets were deep drew and formed in the series of air conditioning chassis production line, then results of blackening for these parts were observed.

2.3. The performance test and characterization

(1) The morphology of the coatings was observed by JSM-5600LV scanning electron microscope (SEM), and the composition was analyzed by IE 300 X energy spectrometer (EDS).

(2) The friction factor was measured by TE friction test machine made by Beihang University. In the test, the samples were installed, and were pulled out under the pressure 200Kgf with the speed of 100mm/min using the flat sliding method at room temperature, then the friction factor of the steel were measured and the surface state of the samples were observed after the test.

(3) The film thickness (film weight) was measured by X-ray fluorescence spectrometer using Si standard curve.

3. Results and discussion

3.1. Passivation of the hot -dip Zn -Al Galvanizing steel

The surface morphology and composition of the black area on the hot -dip Zn -Al Galvanizing extra deep drawing steel after the deep drawing are shown in Fig.2 and Table 1. Thus, the morphology of normal area was dark and the black area was more clearly. The Si in the black area (the Si content in the Al-Zn coating was only about 1.6%, so Si was mainly from the passive film) was significantly lower than that in the normal area, so the passive film was serious damage occurred in the drawing process. And the O content should also be reduced with the passive film damage, but there is no significant difference about the content of O, so the Al-Zn coating occurred oxidation.

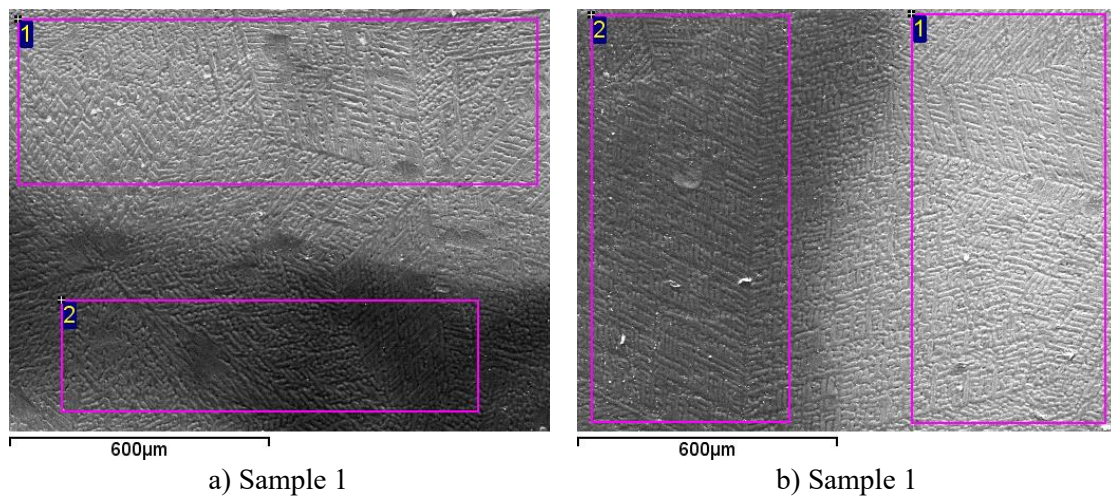


Fig.2 The surface morphology of the black area

Table 1 The composition of the black area %

Spectrum		O	Al	Si	Zn
Fig.2 a	1	15.27	38.84	1.37	44.52
	2	16.65	35.06	11.05	37.24
Fig.2 b	1	18.52	38.38	1.96	41.14
	2	18.91	36.35	15.03	29.71

Therefore, the reasons of blackening after drawing were following:

- (1) In the drawing and forming process, the passive film was severely damaged due to the serious friction between the hot -dip Zn -Al Galvanizing extra deep drawing steel and the mould;
- (2) The heat produced in the friction process promote the Al-Zn coating to react with oxygen in the air and produce oxidation, then the surface blackening.

3.2. The preventive measure

The blackening after drawing was caused by the friction, so it was necessary to improve the self-lubricating property and reduce the surface friction factor of the hot -dip Zn -Al Galvanizing extra deep drawing steel. The friction factor of different samples are shown in Table 2, and the surface state after testing was shown in Fig.3.

Table 2 The friction factor of different samples

Sample	The number of Cold roll	The friction factor	Sample	The number of Cold roll	The friction factor
A (PanGang)	11W008292000	0.253	B (PanGang)	11W008307000	0.173
	11W008300000	0.330		11W008306000	0.165
	11W008304000	0.351		11W007958000	0.149
DB	---	0.235	BG	---	0.238

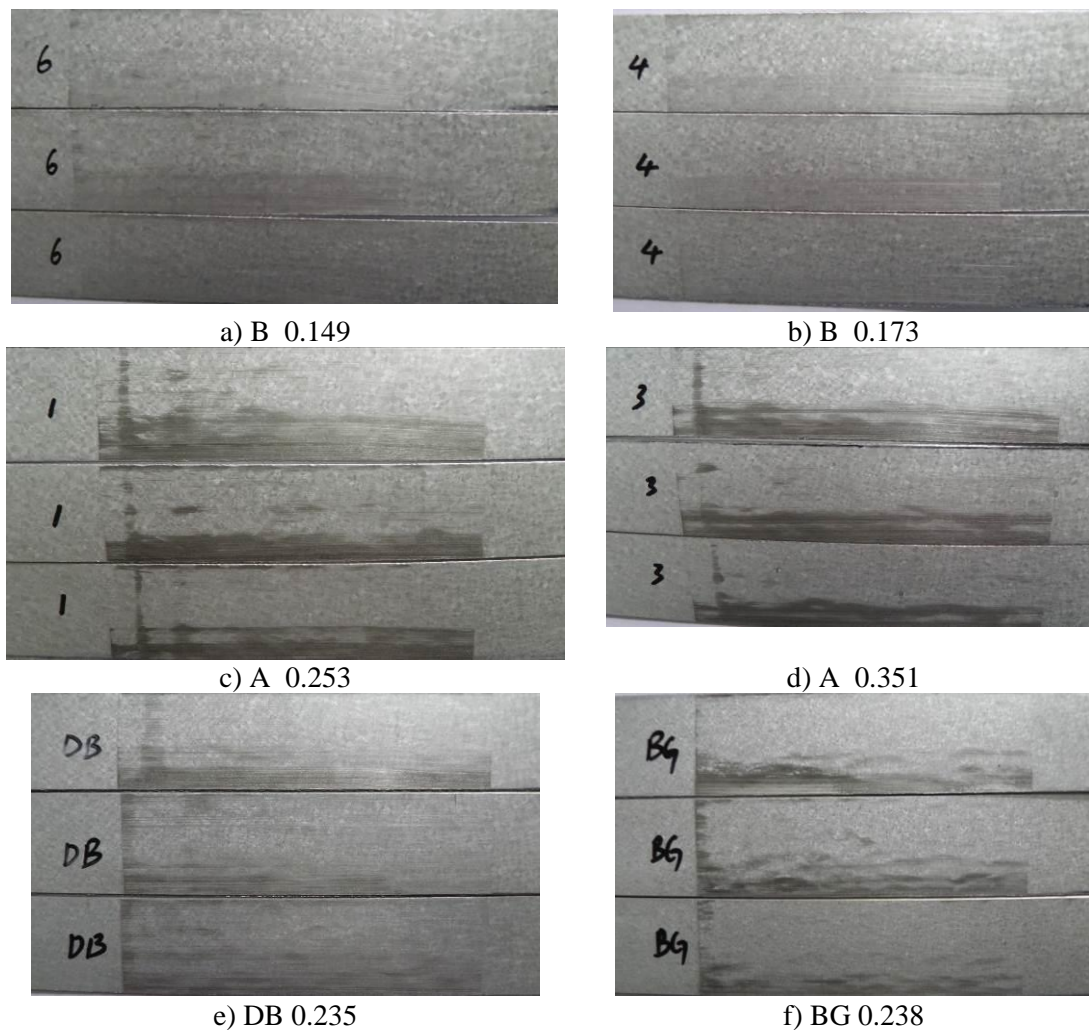


Fig.3 The surface state after testing

After deep drawing in the series production line, the passivated hot-dip Zn -Al Galvanizing extra deep drawing steel A appeared obviously blacken, B did not appear blacken, the DB and BG appeared slightly blacken. These results after deep drawing were consistent with the results of the friction factor test. Therefore, the friction factor of A (0.253~0.351) was a little bigger, the A appeared obviously blacken. The friction factor of DB and BG (0.235, 0.238) was in middle, DB and BG appeared slightly blacken. The friction factor of B (0.149~0.174) was a little smaller, B appear no blacken. When the friction factor was less than 0.2, the sample does not appear blacken, and the severity degree about blacken increased gradually as the friction factor of the hot-dip Zn -Al Galvanizing steel increased gradually. So the preventive measure that could effectively prevent the hot-dip Zn -Al Galvanizing steel blackening after deep drawing were that the surface passive film on Zn -Al coating had self-lubrication property and the friction factor of the surface below 0.2.

3.3. The Effect

The self-lubricating coating has been applied to of the hot -dip Zn -Al Galvanizing extra deep drawing steel. At present, the self-lubricating hot -dip Zn -Al Galvanizing that the friction factor below 0.2 has been punched to make nearly ten million chassis of air conditioner, and no blackening has occurred. So the technology that the surface passive film on Zn -Al coating had self-lubrication and the friction factor of the surface below 0.2 is the effective measure to prevent the deformation area of the hot -dip Zn -Al Galvanizing extra deep drawing steel blackening during the drawing process.

4. Conclusions

(1) The blackening on the hot -dip Zn -Al Galvanizing extra deep drawing steel during the drawing process was caused by Zn -Al coating corrosion after the damage of passive film.

(2) The effective preventive measures were that the surface passive film on Zn -Al coating had self-lubrication and the friction factor of the surface below 0.2.

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