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DECORATIVE SURFACES OBTAINED BY HOT-DIP GALVANIZATION

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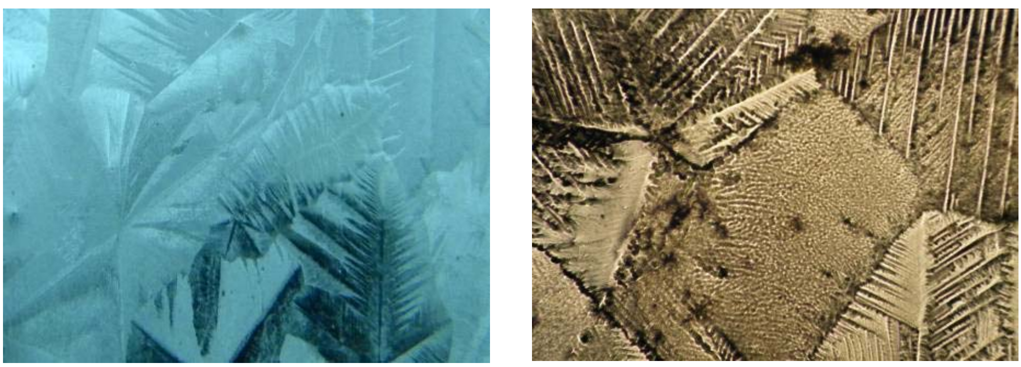
Abstract:

The surface morphology of the galvanized sheets is formed after the solidification of the melted metal, carried along the carrier strap during its extraction from the zinc bath. The surface layer quality depends on the fluidity of the melting, on its superficial tension and on the solidification characteristics, according to the chemical composition of the melting. The elements of micro-alloys can improve the surface of galvanized steel with qualities such as: uniformity, texture, luminosity. Depending on the combination elements of micro-alloying the surface can have different types of metallic layers with an important effect on the coating morphology. The research we made revealed the important effect it had for alloys with Al, Sn, Bi, Pb on the coating layer morphology.

Keywords: galvanization, surface quality

Introduction

The surface quality of the steel straps covered with zinc or zinc-based alloys, is important both for the anti-corrosive of the coating [1] and for custom requests [2]. The surfaces of the galvanized straps present metallic brightness, light silver color, with dendrite zinc crystals („zinc flowers") of different shapes and sizes according to the chemical composition of the hot-dip bath (Fig.1).



a) b)

Fig.1. The surface morphology of the straps covered with zinc with „zinc flowers" [3]: a) macroscopic 5X; b) microscopic, 50X

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You can obtain coatings without dendrite crystals if you use the pure zinc baths, or you may reduce the flowering effect by different methods (Fig. 2).

a) b)

Fig. 2 The surface morphology of the straps coated with zinc without „zinc flowers" [3]: a) macroscopic 5X; b) microscopic, 50X

The surfaces can be even (Fig. 3a) as well as coarse (Fig. 3b).

a) b)

Fig. 3 The macrostructure of the galvanized surfaces, 50X [3]: a) smooth aspect, b) coarse aspect

The decorative aspect with dendrite crystals is preferred for galvanized sheets. This morphology is not recommended for paint coating, as the structure can be observed after varnishing and multiple layers of paint are required in order to get an even and uniform surface.

According to the chemical composition of the zync melts, the surface can have different types of metallic layer which can have an important effect on the coating aspect [4, 5]. This paper presents the surface morphology of zinc coatings with Ni, Sn .Bi, Al, Cd, trough the sheet steel in order to improve the operating characteristics of zinc layers.

Experimental

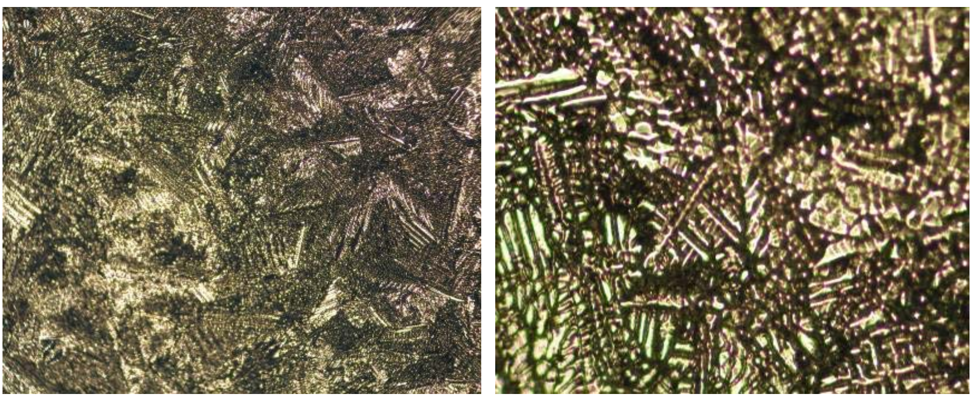
In the experiments made to obtain decorative coatings we tested different baths of zinc alloys (Table 1)

Table 1. The chemical composition for microalloyed zync melts

Sample alloy	Chemical composition, [%]						
	Ni	Bi	Sn	Cd	Pb	Al	Zn
Zn- Ni-Bi-Sn-Cd	0,16	0,71	2,95	0,26	0	0	95,92
Zn- Ni-Pb-Sn	0,16	0	2,88	0	0,72	0	96,24
Zn- Ni- Pb-Bi-Sn	0,16	0,41	3,49	0	0,43	0	95,51
Zn-Bi I	0	0,27	0	0	0	0	99,73
Zn-Bi II	0	0,36	0	0	0	0	99,64
Zn-Bi III	0	0,52	0	0	0	0	99,48
Zn-Bi-Sn-Al	0	0,44	0,86	0	0	0,33	98,37

The alloys were made with fine pure metals and were mixed mechanically for homogenization. One can notice the changing of the surface morphology depending on the elements in the alloy, as compared to surface morphology resulted at coating with pure zinc. Thus, for alloys with Ni-Sn-Pb, the surface morphology revealed the formation of big crystals with a fanned aspect (Fig.4). If Pb is changed to Bi the crystals get significantly finer (Fig.5).

Fig. 4. The coating morphology with Zn-Ni-Pb-Sn, 50X



a) 50X b) 200X

Fig. 5. The coating morphology with Zn-Ni-Pb-Bi-Sn

Fig. 6. The surface morphology obtained in hot-dips Zn + 0,27% Bi, 50X

As for alloys with bismuth the morphology of the coated surface revealed the forming of some long dendrites (Fig. 6), getting grouped into angled or parallel stripes (Fig. 7) or in parallel stripes (Fig. 8) when the content of bismuth increases. The presence of the bismuth gives the surface a yellowish hue.

Fig. 7. The surface morphology obtained in baths of Zn + 0,36% Bi, 50X

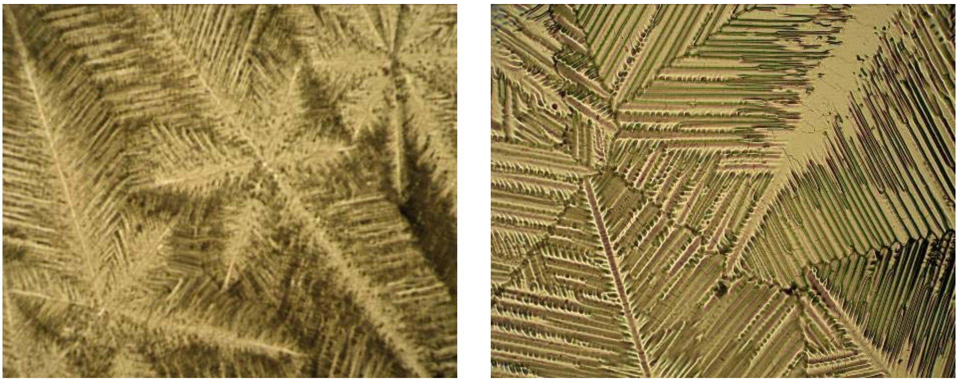
Fig. 8. The surface morphology obtained in baths of Zn + 0,52% Bi, 50X

Alloys with Sn-Bi-Al obtained „zinc flowers" with an even increase on all solidification directions, with an attractive shiny aspect. The effect of brightness is given by the presence of aluminum (Fig. 9), and the feather aspect of the dendrites by the simultaneous alloying with bismuth and tin. The coating obtained in the presence of these three alloying elements had the most attractive surface aspect and no visible flaws.

The micro-alloying elements used can enhance the surface quality of the galvanized steel by conferring: uniformity, texture, luminosity.

The surface layer properties depend on the melting fluidity, its superficial tension and the solidification characteristics [6]. Depending on to the combination of the micro-alloying elements the surface can acquire different types of metallic coatings with important aesthetic effect. The research we made highlighted their important effect on the morphology of the coating layer when using micro-alloys with Al, Sn, Bi, Pb.

The presence of aluminum in the hot-dip bath, even in very low quantities (0,01 – 0,005), leads to the formation of a fine film of Al_2O_3 on the hot-dip bath's surface, hindering the formation of slag that can adhere to the coating surface and lead to surface flaws. In the presence of aluminum one can obtain coatings with a shiny metallic gloss.



a) 50X b) 100X

Fig. 9. The surface morphology obtained in baths of Zn-Sn-Bi-Al

Lead reduces the surface tension and increases fluidity, leading to even and uniform surfaces. It favors the decanting of slag, hindering its adherence to the coating surface.

Bismuth has a similar behavior to Pb, but unlike lead it is not toxic for the environment. Mixed with antimony it favors the formation of some large dendrites resembling feathers.

The cooling process, after removing the straps from the hot-dip bath, has important effects on the iron content of the deposited layer and on the coating surface. Research [7] proved that reaching a temperature of 300°C in the cooling period favors the Fe diffusion in the Zn layer with an increase in quantity of the Zn-Fe alloys that can render fragility to the coating. Increasing the cooling period (slow cooling) leads to the flaw named „heat spots”, i.e zones in which the Zn-Fe alloy sinks in the coating surface. Quick cooling leads to fewer „zinc flowers” (the germination speed and the crystal growing speed present high values). If the galvanized strap is to be painted, or if the customers do not want a surface with „zinc flowers”, there are several methods, which usually combine an increase of the cooling speed with stimulation of the germination speed, by which that can be achieved. The most common methods are: cooling with an air-jet, cooling in atmosphere with zinc powder or spraying with zinc powder.

Conclusions

The research we made revealed the important effect of galvanization on the morphology of the coating layer obtained in hot-dip baths with alloys of Al, Sn, Bi, Pb.

In zinc baths micro-alloyed with bismuth the surface morphology shows formations of some long dendrites and the coating has a yellowish hue.

When micro-alloying with Ni-Sn-Pb, the coated surface presents crystals with a fanned aspect.

When micro-alloying with Sn-Bi-Al we obtained „zinc flowers” with an uniform increase in all solidification directions, with an appearance of snowflakes, decorative and shiny.

The presence of aluminum in the hot-dip bath, even in very low quantities (0.01 - 0,005%) leads to glossy metallic coatings.

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