Journal for Technology of Plasticity, Vol. 37 (2012), Number 2

THE INFLUENCE OF BENDING ANGLE OF THE ZN COATED SHEET METAL ON SURFACE MORPHOLOGY

*Michaela Císařová, Milan Dvořák**

Brno University of Technology, Faculty of Mechanical Engineering, Institute of Manufacturing Technology, Department of Metal Forming and Plastics, Technicka 2896/2, 616 69 Brno

ABSTRACT

This paper deals with the influence of sheet metal bending on the surface morphology of the zinc coating. The text below describes the application of zinc coating sheet metal in practice. Experiments were performed on the selected type of sheet metal. The thickness of the zinc coating was measured. The sheet metal has been subjected to technological bending test, which was evaluated in the terms of behavior, morphology and deformation of the coating. The results of performed experiments and resulting conclusions are summarized as well.
Keywords: *zinc coating, sheet metal, bending, morphology of coat*

1. INTRODUCTION

The zinc coating sheets are widely used in different fields of engineering e.g., civil engineering. The zinc coatings provide sheet cathodic protection in the case of damaged coat, they are also very resistant to mechanical damage and due to climatic conditions naturally attended to lose zinc layer. The rate of decline of the coating is insignificant (approximately 0.02 mm · year^{-1}) and material properties do not change. An alloying coat is created on zinc-components in the process of metallurgical reaction. Intermetallic bond is created between iron and zinc in the process of reaction in a zinc plating bath (the temperature of zinc melt is 450° C). The zinc is partly diffused to ferrite (alpha-iron) in these terms, where is composing single substitution is solid solution with 4 % zinc in the top layer (Fig. 1). There is a binary iron-zinc phase (γ, δ and ζ) in this substrate. When the component extends from zinc plating bath, the fine zinc always sticks to surface of component (phase η). An individual alloy phases are in mutual rate: the thickness and the structure depend on the progress of metallurgical reaction. The hardness phases is comparable with hardness of priming material (phase δ is harder); zinc coat shows very good resilience against abrasion and impacts [1], [3].

*Corresponding author's email: dvorak.m@fme.vutbr.cz

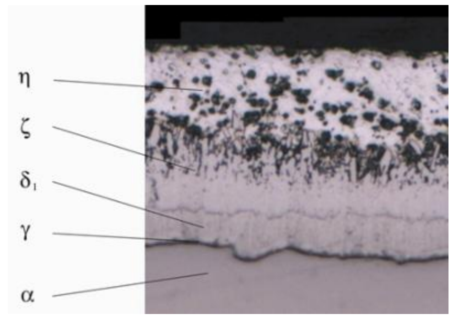

Fig. 1 - The perpendicular cut through a zinc coat

The thickness and design usually serve for quality rating of the zinc coating according by ČSN EN ISO 1461 standard. After visual inspection, when visible defects are controlled, such as ungalvanized places, protrusions, blisters or bubbles, a zinc ashes or flaking of the coat, the thickness of a coat can be controlled. The control is done by a local determination of the thickness (a coat is measured min. 5x in limited area of measure, the mean value individual measures give a value of a local average of the thickness) and an average thickness of a coat (the measure is done on the component in various areas).

For the measurement of coat thickness, a magnetic method is usually used for a piece galvanized in according with the valid standard. The magnetic method is fast, easy and it does not damage the product and its surfacing coat.

The coat adhesion is a property which is difficult to define and measure. It is the absorption power of mechanical load, e.g. bending, rolls bending, resistance to impacts and rubbing.

It is depended on the proportion of single intermetallic coat phases, i.e. on silicon contest, which is encored to quiet steel as deoxidizer and layer thickness, which is influenced by time in a zinced-bath.

All coat properties, e.g. design, thickness and coat adhesion must be in good quality to meet the recommended quality during forming materials. The malleability is a property, which preserves the utility of a plate during forming change. The issue is a corrosion resistance at zinc coating sheet. There is a limit state of basic material and surface layer.

When the component is drawn from zinc coating sheet, coat protection must be ensured. Reduction of coat thickness takes place during forming process. There has to be enough coat plasticity due to result of a plastic deformation in critical section of forming component; the compatibility coat can be ruptured in contact area with a coat. The coat must have enough plasticity, due to inception of a crack and peel off a basic material.

2. EXPERIMENTS

The zinc coating sheets are applied in cold-working, most often bending, roll bending and cupping operations in engineering practice.

The experiments were performed from common available zinc coating steel 10 004 weighing 250 g m^{-2} with mechanical properties: $R_{p0.2}$ = 285 MPa, R_{eH} = 321 MPa, R_m = 368 MPa, A_{50} = 29.6 %. The dimensions of specimens were 220x330 mm and their thickness was 0.5, 0.8 and 1.0 mm.

Prior to experiments, the zinc-coat thickness was measured by Positector 6000 (USA) instrument, which was in a span from 14 to 20 µm, and a visual control of zinc coat against visual defects was performed as well.

The values of (elastic) spring on specimens were measured in the process of bending by Tarnogrodsky instrument at 40°, 60°, 80°, 100°, 120°, 140° and 160° with inner bending radius R17.5 mm. The angle values of elastic spring are graphically shown in Fig. 2.

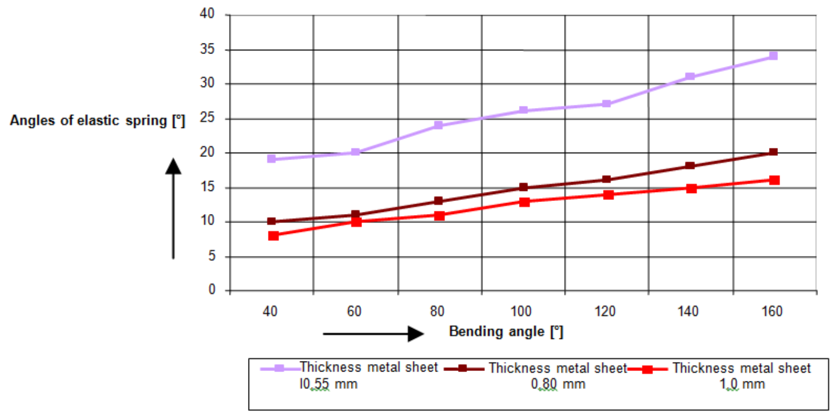

Fig. 2 - The grafical presentation of rate of a suspension angle on V-bend

The results of outer drawing coat thickness are arranged in the Table 1.

Table 1 - The assessment of a bend-radius influence the coat thickness in the place of bend

Marking of specimen	Nominal sheet thickness [mm]	Inside bend radius [mm]	Measured thickness [µm]	
			Coat (outside bend)	
			Bend	Plane
Sample 17	0.55	R 17.5	20.4 ± 2.8	23.8 ± 3.2
Sample 18	1.00	R 5	15.1 ± 2.7	23.3 ± 5.3
Sample 19A	0.55	R 5	20.4 ± 7.2	23.8 ± 4.1
Sample 19B	0.80	R 5	18.6 ± 5.0	23.4 ± 5.6

The most intensive thinning of a zinc coat was caused by the bend sheet metal sample having 1.0 mm over the roller that has R5 radius; the smallest thinning of a zinc coat was caused by the bend sheet metal sample having 0.8 mm over the roller that has R5 radius.

The morphology of zinc coat was the next observed (Fig.3). The zinc coat morphology of sheet drawing has a considerable influence on the effect for painting and tribological conditions. The best choice for machining sheet is the cylinder surface with a fine granulated material (SBT – Shot

Blast Texturing) or an electronic discharge (EDT – Electric Discharge Texturing) or more modern methods, for example a laser beam machining (LT – Laser Texturing), electron beam (EBT – Electro Beam Texturing) and achromatizing work cylinder (PRETEX process).

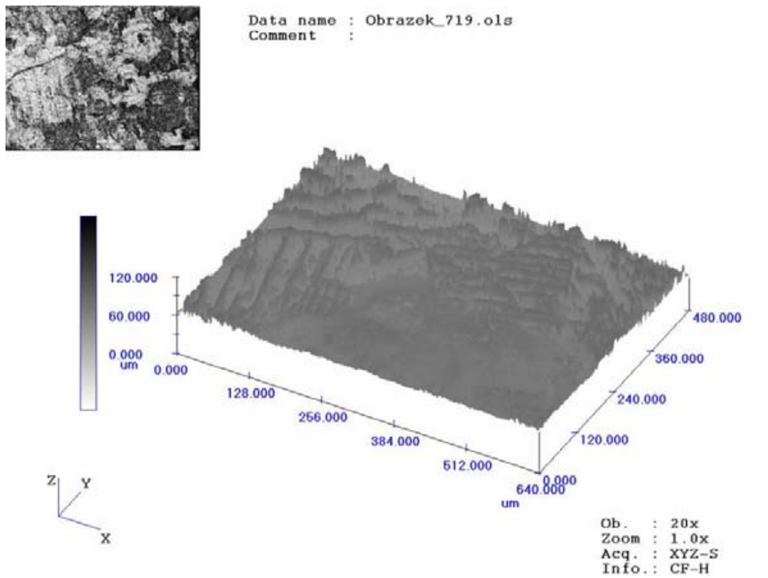

Fig. 3 - The initial state of zinc-surface sheet

The surface pictures were taken by an electronic microscope LEXT. The specimens no. 11 and 16 were chosen for a bend test. The rifts on the outside of draughty coat surface in a bend were compared with bend radius and with thickness of a basic material. The quantity of rifts grows depending on radius and thickness.

The size of a coat deformation was inspected next. The deformation was not intensive; initial and deformation states were not noticeably different. The tackle radii size was bigger than needed (R5, R17.5 mm).

When the surface is not finally rolled again (Fig. 4, 5), the grid in not obvious for usual use in finally determining coat morphology. That can be improved by evaluation (stochastic, deterministic, multi-deterministic or deterministic-stochastic morphology). The suitable sheet morphologies ensure the special type of a surface machine glazing cylinder. Previously mentioned in the text and the glazing cylinder have ensured the suitable optimal surface for malleability of a sheet and the quality of a lacquer.

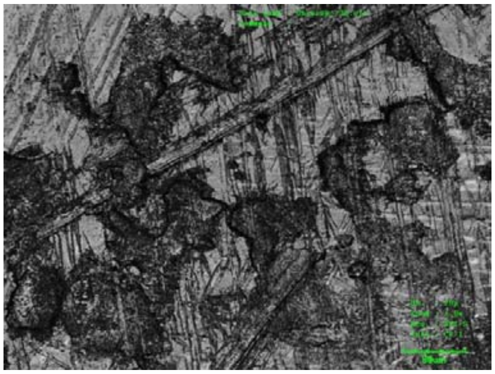

Fig. 4 - The example of a surface specimen no.11 after deformation, 480x magnification

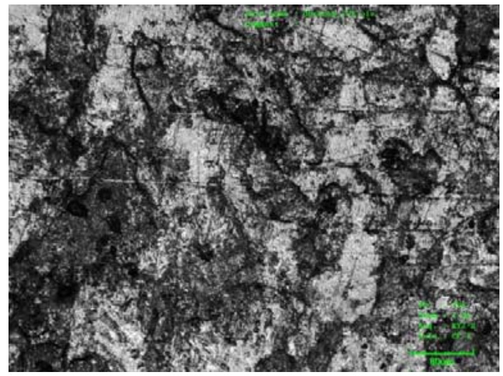

Fig. 5 - The example of a surface specimen no. 16, after deformation, 480x magnification

3. CONCLUSION

During the control of the surface thickness (0.5, 0.8, 1 mm) it has been discovered that the experimental specimen did not comply with maker‘s values in the test. The biggest thinning of a zinc coat was caused by the bend sheet-strip that has 1 mm over the tackle having R5 radius, the smallest thinning of a zinc-coat was caused by the bend sheet-strip that has 0.8 mm over the tackle having R5 radius.
The number of a coat breaks scope up with the same bend radius and the thickness sheet of a basic material increase as well. The deformation side of starting and final condition was negligible due to bad selection of the cylinder radius. The type of coat morphology was not possible to determine on specimens no. 11 and 16, as raster was not appreciable so that it was not possible to analyze the coating.

ACKNOWLEDGEMENT

The article is supported by the grand project BUT Brno - BD 1393016 Research on the behaviour of the coating adhesion to the surface forming. BUT, 2009.

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UTICAJ UGLA SAVIJANJA NA MORFOLOGIJU POVRŠINE KOD LIMA SA PREVLAKOM OD CINKA

Michaela Císařová, Milan Dvořák

[1]*Brno University of Technology, Faculty of Mechanical Engineering, Institute of Manufacturing Technology, Department of Metal Forming and Plastics, Technicka 2896/2, 616 69 Brno*

REZIME

U ovom radu vršeno je istraživanje uticaja ugla savijanja kod lima sa prevučenim slojem od cinka na površini. Prikazana je oblast piomene prevlaka od cinka u industriji. U eksperimentalnom istraživanju vršeno je i merenje debljine nanesene prevlake cinka. Magnetna metoda je najpogodnija za merenje debljine prevlake jer je veoma jednostavna i ne oštećuje materijal. Lim sa prevlakom od cinka je bio ispitivan na testu savijanja, a vršeno je i ispitivanje ponašanja lima u tom procesu, kao i karakteristike deformacije i morfologije prevlake. Jedan od glavnih problema koji se javlja pri savijanju lima sa nanesenom prevlakom je stanjivanje i/ili pucanje prevlake. U radu su posebno naglašeni eksperimenti u kojima je došlo do velikog stanjivanja debljine prevlake. Na kraju rada data su zaključna razmatranja.

Ključne reči: *prevlaka od cinka, lim, savijanje morfologija prevlake*