SURFACE QUALITY IMPROVEMENT OF HOT-DIP GALVANIZED STEEL SHEET, USING HARD CHROME PLATED SKIN PASS MILL ROLL

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Outline

Introduction
• POSCO-TCS and CGL Layout
• Skin Pass Mill Facility

Background
• Roll Maintenance Process
• Chrome coating technology
• Electro discharge texturing (EDT) Technology

Operation Test Result
• Cr coated and non-Cr coated work roll life time
• The effect of SPM roll force to the surface properties
• The constant surface quality of hard chrome coating roll
Introduction of POSCO-TCS

POSCO Coated Steel (Thailand) Co., Ltd.
7/448 Moo 6 Amata City Industrial Estate, Mabyangporn, Pluakdaeng, Rayong THAILAND 21140

• Products: Hot Dip Galvanizing Steel (GI)
  Hot Dip Galvannealing Steel (GA)
• Capacity: 450,000 Ton/year
• Customers: Automotive (Toyota, Nissan etc.)
  Home Appliance (Samsung, LG etc.)
  Color Coating (PPT, Dong bu etc.)
Introduction of CGL (Continuous Galvanizing Line)

POSCO-TCS Continuous Galvanizing Line (CGL)

Entry Section
• Two Pay Off Reels
• Seam Welder machine
• Pre-Cleaning section (Electrolytic & Brushing)
• Entry Looper

Coating Section
• Vertical Annealing Furnace
• Molten Zinc Pot
• Galvannealing Furnace
• Air/Mist Cooling Tower
• Skin Pass Mill & Leveller
• Chemical Passivation

Exit Section
• Exit Looper
• Turret-style side trimmer
• Vertical/Horizontal Inspection
• Electrostatic Oiling machine
• On-line Defect Detector
• Two Tension Reels

Size: 0.3~2.3mmt, width 1,860mm
Grade: CQ, IF Steel (DQ, DDQ, EDDQ), AHSS (~60kg)
Skin Pass Mill Facility

**Purpose**
- To Improve Mechanical Properties (Yp-El)
- Shape correction (Ondulation, Flatness)
- Roughness and Surface Appearance Control

**Specification**
- Type: 4-Hi 1-Stand Work Roll
- Roll Force Max (Ton): 1000
- Elongation Max (%): 3.0
- Roll Change: Shift Car

**SPM Roll Change Process**
- **Old Roll traverse (Roll out)**
- **Side shift frame is moving**
- **Work Roll traverse (Roll in)**
Skin Pass Mill Facility

Skin Pass Mill Work Roll

**Non-coated roll:**

- In 2016, POSCO-TCS started operation with non-coated SPM Work Rolls.
- At the time, the work roll worn down after ~200 km.
- The quality of the product is out of standard and required a new work roll frequently.
- The work roll changed 2-3 times a day which means that 10 Tons of product is loss per day.

**Chrome-coated roll:**

- Then the chrome-coated roll is introduced due to its durability and wear resistance.
- However, there are limitation to sourcing the local suppliers.
Roll Receiving Inspection

- Inspection roll surface after receiving roll from production line
  - Check Point: Diameter, Roughness, Condition of surface

Grinding

- Modify roll surface and control roll profile to prevent roll crack
  - Check Point: Roll crown, roughness

EDT

- EDT process is process to provide roughness on roll surface
  - GA product: Low Ra, GI product: High Ra
  * control roughness higher than standard 0.2-0.3 µm

Hard Chrome Coating

- Hard chrome plating is an electroplating process in which chromium is deposited from a chromic acid solution.
  * Hard Chrome thickness: 10±2 µm.

Inspection Roll Surface

- Final for inspection roll surface by check roughness value
  - follow standard of GA and GI product.
- Thickness of surface coating by use CT3 machine (acid analysis)
- Visual inspection: roll surface 100% no defect
Formation of the small craters on the rolls surface is the result from the discharge between two electrodes with a gap control.

**Advantages**
Able to control height and number of peaks by controlling parameters.
Hard Chrome Coating Process

Hard Chrome Coating

Advantages

• High hardness, Wear resistance
• Corrosion resistance
• Low friction, temp. treatment
• Maintain the surface texture when applied thin layer
Operation Test Overview

Operation Test

- Cr coated and non-Cr coated work roll life time
- The effect of SPM roll force to the surface properties
- The constant surface quality of hard chrome coating work roll
Operation Test Result

Strip Surface Appearance

Non-chrome coated roll on GI Product

- 8.5km
- 69km: Flat area/ Worn down
- 200km: Flat area/ Worn down

Chrome coated roll on GI Product

- 15km
- 306km
- 1392km
Operation Test Result

Strip Roughness & Printed Area

* Printed Area Ratio
  : Area of the roll printing mark / the total area

Roughness
(Ra, um)

Printed Area Ratio (%)

Roll Force (Ton)

SPM Rolling Distance (km)
Operation Test Result

The effect of SPM roll force to the surface properties

Optical Microscopic (OM) of GI Product Surface

- RF 100 Ton
- RF 200 Ton
- RF 500 Ton

SEM of GI Product Surface

- RF 100 Ton
- RF 200 Ton
- RF 500 Ton
Operation Test Result

The effect of SPM roll force to the surface roughness

3D Roughness of GI Product

RF 0 Ton

- $Ra : 0.39$, PPI 154.5, $R_{max} 6.77$,
- $Rz 2.89$, RPC 24

RF 100 Ton

- $Ra : 0.75$, PPI 222.3, $R_{max} 7.36$,
- $Rz 4.85$, RPC 35

RF 200 Ton

- $Ra : 0.86$, PPI 230.7, $R_{max} 6.39$,
- $Rz 4.59$, RPC 36

RF 300 Ton

- $Ra : 0.84$, PPI 226.5, $R_{max} 6.28$,
- $Rz 4.69$, RPC 36

RF 400 Ton

- $Ra : 0.99$, PPI 232.8, $R_{max} 6.74$,
- $Rz 5.24$, RPC 37

RF 500 Ton

- $Ra : 1.30$, PPI 260.4, $R_{max} 7.70$,
- $Rz 6.54$, RPC 41
Operation Test Result

The effect of SPM roll force to the surface properties

SEM of GA Product Surface

RF 0 Ton

RF 200 Ton

RF 500 Ton

RF 0 Ton

RF 200 Ton

RF 500 Ton

100x

300x
Operation Test Result

Strip Roughness & Printed Area

- Roughness increased as the roll force is increased.

GI Product

<table>
<thead>
<tr>
<th>Roughness (Ra, um)</th>
<th>Printed area ratio</th>
</tr>
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<tbody>
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GA Product

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Roughness increased as the roll force is increased.
Operation Test Result

Strip Surface Friction Property

- Roll force showed direct relation to friction of GI product
Operation Test Result

Strip Surface Appearance

- The surface appearance is constant throughout the life of the work roll.

GI Product Surface using Cr-Coated Roll

5km 214km 630km

GA Product Surface using Cr-Coated Roll

107km 263km 360km
Strip Roughness & Printed Area

- The surface quality is constant throughout the life of the work roll.

**GI Product**

**GA Product**
The effect of Roll Force

• Improve the surface appearance
  - The higher roll force provide the better appearance and higher strip roughness.

• Control the friction property
  - The direct relation with friction of GI product.
  - The higher the roll force provide higher friction property.

• Control the constant strip quality
  - the constant roll force must be controlled.

The effect of Hard Chrome Coating

• Control the constant product quality
  - The product quality is constant from the beginning until work roll is changed
  - Constant roughness condition
  - Sharper, deeper texture because the weak peaks is protected.

• Increase the work roll life.
  - Reduce work roll changing time and scrap.