WHITE PAPER

# How to Resolve Hot Mill Pick Up Defects on Rolled Aluminum

BY PIERRE TALJAARD, LEAD PRODUCT APPLICATION MANAGER - NON-FERROUS

## Introduction

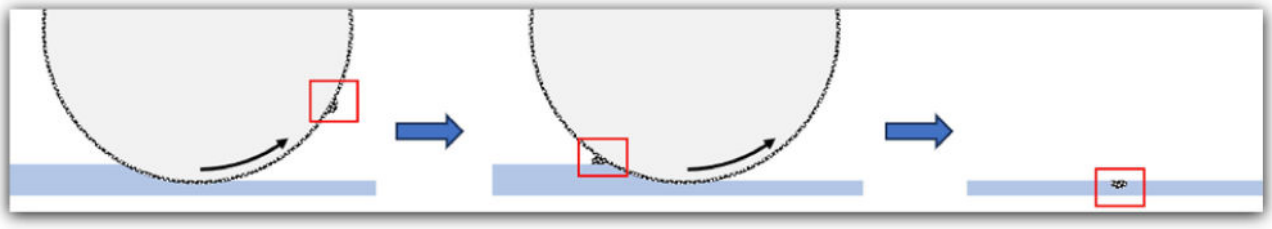
Hot mill pick up is a common surface defect in hot rolled aluminum, especially in high-magnesium alloys like 5182. It arises from the transfer of the work roll coating onto the strip or slab surface during the rolling process.

Hot mill pick up is a near-surface defect that can detrimentally impact on the visual appearance of the final product, such as can ends used for beverage cans. In severe cases it may affect the mechanical integrity of the product and may lead to beverage can leaks.

In this white paper we take a closer look at what causes this defect and how it can be managed.

## What is Hot Mill Pick Up?

Hot mill pick up occurs when material from the work roll coating dislodges and embeds into the surface of the aluminum strip or slab. This coating, made up of complex aluminum and magnesium oxides in combination with organic soaps from the rolling oil, forms through mechanical adhesion and interaction with lubricants in the roll gap. While a stable and uniform coating is beneficial for the hot rolling process, an excessively thick or unstable coating can lead to defects that only become visible after anodizing the surface.



**Material from the work roll coating dislodges and is rolled into the surface of the aluminum strip, causing a hot mill pick up defect.**

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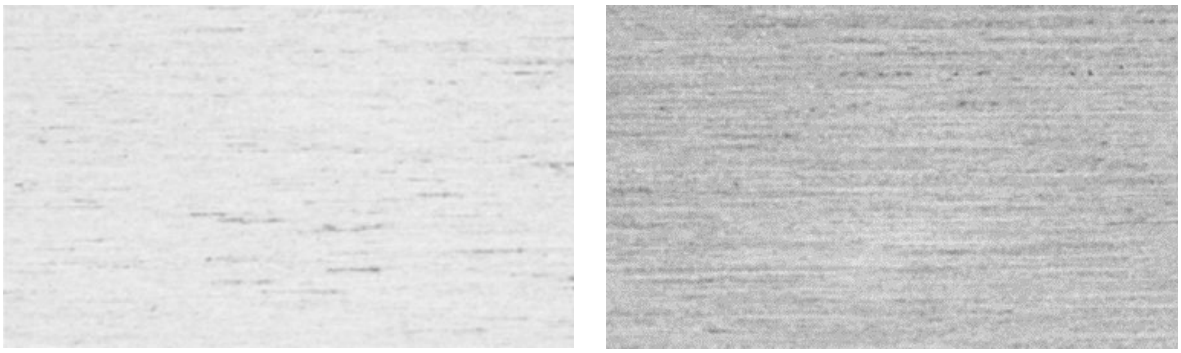
## Identifying Hot Mill Pick Up Defects

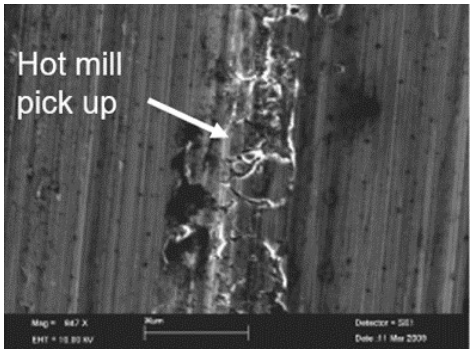
Hot mill pick up is not visible on the as-rolled strip, and only becomes visible after electrolytic anodizing of the strip surface. After the anodizing process the defect appears as black lines of varying density and length. The images below show levels of unacceptable and acceptable hot mill pick up produced by reduction in roll force, which is but one of many variables that may impact on the degree of hot mill pick up.



**Typical hot mill pick up surface distribution on anodized hot rolled 5182 alloy strips:**
**Left: high roll force, unacceptable level of hot mill pick up. Right: reduced roll force, acceptable level of hot mill pick up.**

### Analytical Methods

Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Spectroscopy (EDS) are powerful tools to confirm the presence of hot mill pick up, especially in processes downstream from hot rolling. SEM analysis of hot mill pick up will reveal brittle structures in the areas of defect, with signs of breaking up in the rolling direction.




**SEM analysis reveals brittle structures in the hot mill pick up areas.**

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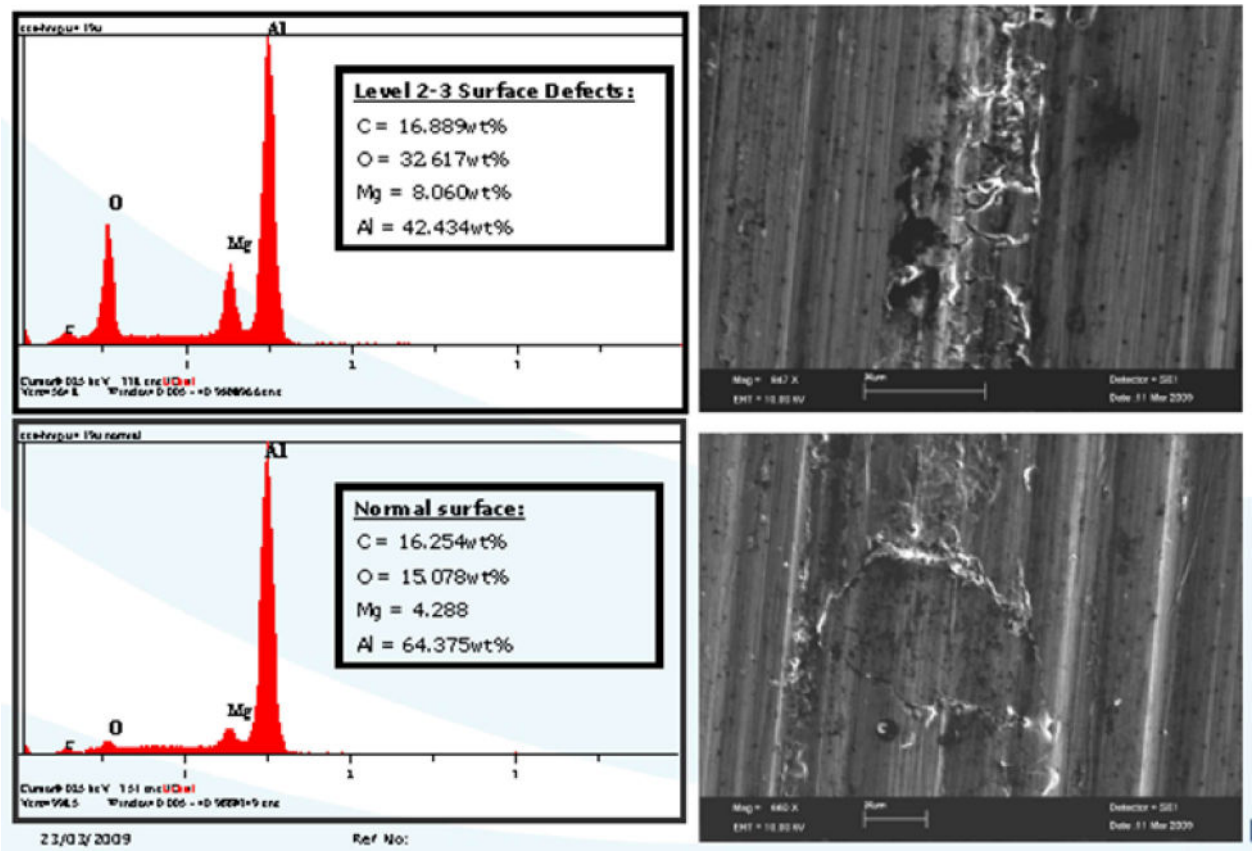
EDS analysis of hot mill pick up will show elevated levels of oxygen and magnesium in the defect areas compared to the as-rolled surface, indicative of the highly oxidized work roll coating that transferred onto the strip surface. Quaker Houghton offers both SEM and EDS analysis services at several of our laboratories and can assist in characterizing hot mill pick up and other surface defects.




**Elevated levels of oxygen and magnesium found in EDS analysis indicate hot mill pick up.**

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## Variables Influencing Hot Mill Pick Up Defects

Understanding and managing the variables within a process model is essential for minimizing hot mill pick up and ensuring high-quality hot rolled aluminum surfaces. The table below summarizes some of the key variables to be considered.

| | |
|---|---|
| **Ingot Preheating** | |
| Preheating rate and soaking time | High-magnesium alloys are slowly heated and soak times are restricted to control magnesium migration and limit the formation of harmful magnesium-oxides on or close to the ingot surface. |
| **Hot Rolling Practices** | |
| Work Roll Brushing | Controls the thickness of the work roll coating. The type of abrasive, bristle diameter, and brushing setup are important factors. Work roll brushing is one of the most powerful process actuators to control work roll coating. |
| Work Roll Roughness | Strongly affects the roll gap film thickness and coating stability. Work roll roughness is controlled through a range of roll grinding variables. |
| Work Roll Temperature | Emulsion plate out, necessary for efficient roll gap lubrication, is strongly dependent on achieving and maintaining work roll temperatures within a critical range. |
| **Emulsion Management** | |
| Viscosity | Adjusting viscosity can improve hot mill pick up performance by reducing rolling load and coating thickness. |
| Lubricant Additives | Adding oleic acid or esters can enhance lubrication and reduce defects. |
| Emulsion Stability | Larger oil droplets and higher oil concentrations improve lubrication and reduce sticky residues. |

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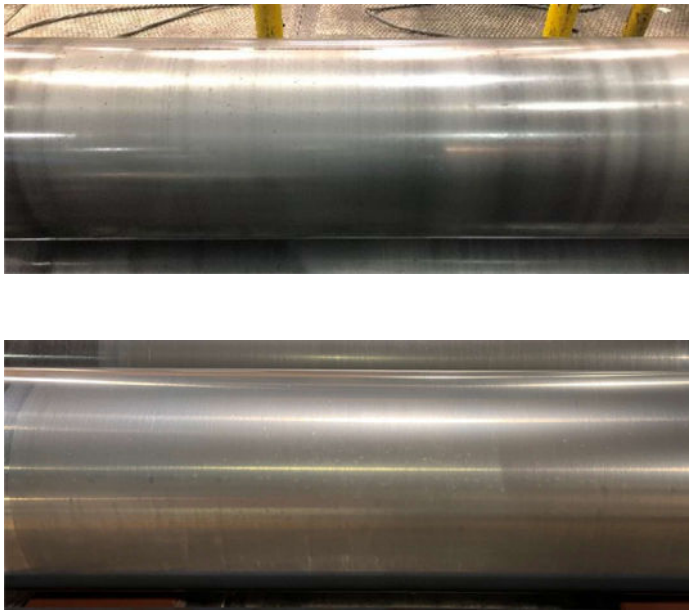
The work roll coating appearance is a good indicator of the process stability. The images below illustrate how an emulsion formulation change and rolling process optimization improved work roll coating stability from being inconsistent and unstable across the width of the work roll surface (before) to a highly stable and uniform coating (after).



**Before: Unstable work roll coating (above). After: Stable work roll coatings (below).**

## Resolving Hot Mill Pick Up

Hot mill pick up can be resolved through a structured approach consisting of root-cause analysis and implementation of preventive actions:

- Measurement and benchmarking of the critical process variables.
- Process variable analysis to determine probable cause and effect.
- Optimizing practices and procedures to deliver the most robust operating conditions for achieving benchmark surface quality.
- Introducing measurement and control procedures to ensure adherence to practices.

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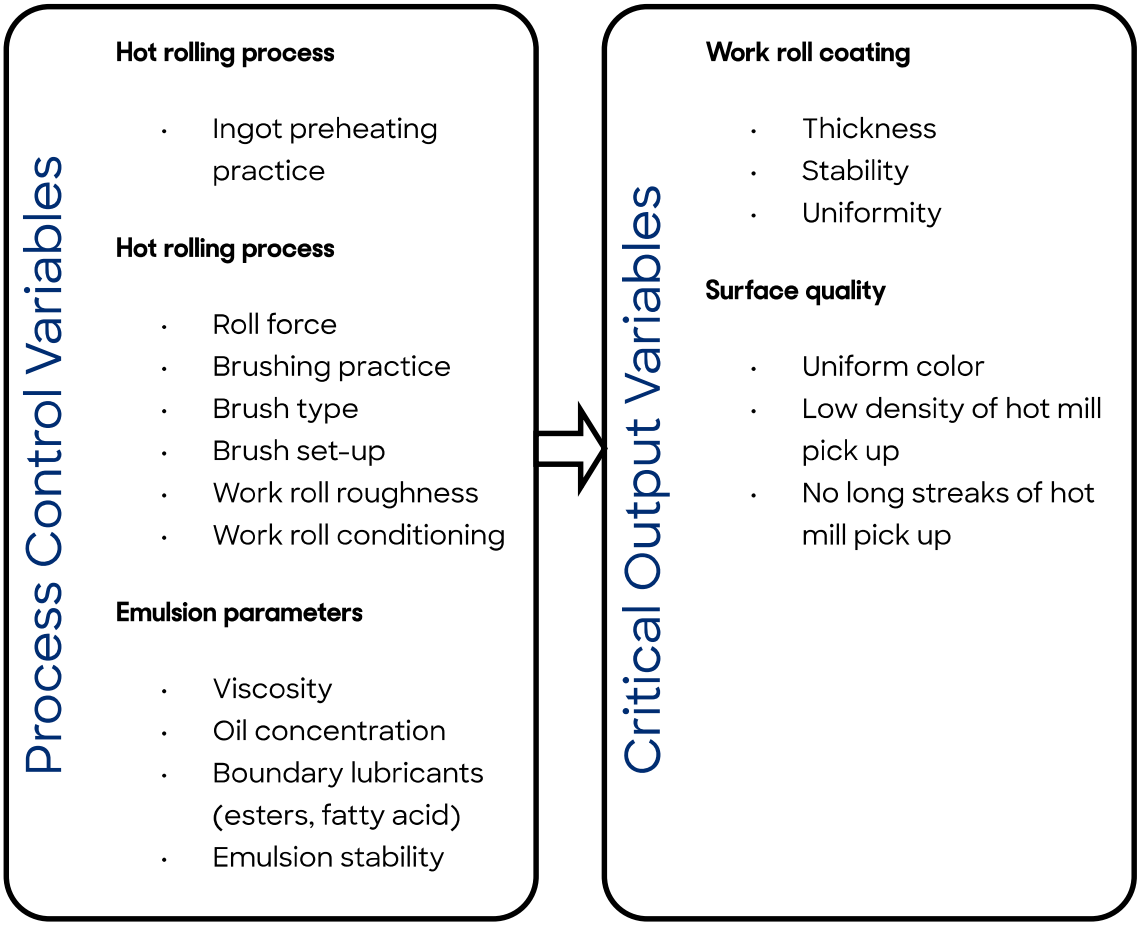
A process model helps summarize the key process control variables and critical output variables necessary for managing hot mill pick up. Benchmarking these variables involves detailed control practices for ingot preheating, rolling conditions, and emulsion management. The following process model illustrates the multiple process variables that can influence the generation of hot mill pick up.




By carefully controlling the rolling process and maintaining stable work roll coatings, rolling mills can significantly reduce surface defects and improve the overall quality of their products.

With many decades of hands-on aluminum rolling experience, Quaker Houghton teams can carry out detailed process audits and apply structured problem-solving principles to optimize processes and improve performance.

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