Cold rolling is an important part of the manufacturing process for thin aluminum strip and sheet. Effective quality control at this stage, by monitoring dents, scratches and other surface defects, can protect from claims and reduce costs throughout the production process.

The speed of the cold rolling mill and the hot, wet environment (which leads to steam) makes manual inspection very difficult, allowing control and inspection only at the beginning and end of the coil. However, these factors can also present challenges to an automated system.

AMETEK Surface Vision’s SmartView® system provides an effective solution that overcomes the difficulties of the cold mill process to deliver reliable, highly sensitive defect inspection in real time, supported by streaming high-definition video that allows re-inspection without re-coiling.

Cold rolling aluminum is a critical process used mainly for reducing the thickness of hot rolled strip to the final gauge required for its end-use which in the case of standard household foil can be as thin as 0.016mm.

The basic process involves squeezing strip material between a pair of driven rolls set to a gap less than the original strip thickness. The overall thickness reduction is achieved by repeatedly passing through the same rolling mill stand with the roll gap reduced for each pass or by passing once through multiple rolling stands with each set of rolls successively set to a smaller gap.

During cold rolling, the strip can work-harden depending on the amount of thickness reduction or on the particular alloy. In some cases, this can be used to achieve the desired mechanical properties or if not required, returned to a more ductile, softer condition by thermal annealing.

Very high rolling loads and roll drive power is required to draw the strip through the roll gap which generates heat build-up in the strip and the rolls.

Complex rolling algorithms are used to control many process variables including roll gap, load, shape, speed, and coolant sprays to ensure high-quality strip is produced efficiently.

Producing strip of high surface finish quality, without defects and good overall flatness or shape is also critical to meet required specifications, and whilst shape defects can be rectified in post rolling operations, surface defects are not so easily removed or repaired. Therefore, it is important to detect emerging surface defects caused by upstream operations or from the cold rolling mill as early as possible at high rolling speeds.

Surface inspection at this stage is important to ensure that the metal meets the required quality. It can detect defects that may not emerge during the prior hot rolling process and allows action to be taken to deal with repeating defects.

This quality control helps to reduce scrap or downgraded product, improve productivity and reduce costs by avoiding the further processing of substandard metal.
A KEY DECISION POINT

Surface inspection can be used at several points in the aluminum production process, including the hot rolling mill and the end of the process. However, there are significant advantages to inspection at the cold rolling mill. Some defects are not visible in hot rolling, and only appear when the metal’s thickness is reduced by cold rolling. In addition, the cold rolling mill is a key decision point for plant operators. At this juncture, they can make an informed decision about what happens with this cold-rolled material – does it go on for further processing, and to industries that demand high-quality product, or does it go to less demanding customers? Further processing requires further investment by the operator, so a data-driven decision at this point can prevent wasted resources and reduce unnecessary costs.

Inspection of the surface at the end of the manufacturing process will accurately determine the quality of the final product, but by this point a lot of investment will have been put into the metal product. Making the cold rolling mill the central decision point will significantly lessen the chances that this investment is wasted.

Another reason why quality control at the cold mill is important is the speed of the process. If a high-speed mill develops a repeating defect, it may produce several coils before the defect is spotted.

However, if the defect is spotted quickly at the cold rolling mill stage, the operator can react swiftly to rectify the problem, reducing waste or substandard product.

CHALLENGES IN SURFACE INSPECTION

The cold rolling mill operates at very high speed, typically around 1400 meters per minute or higher, making it impossible to visually inspect the metal surface using manual techniques.

In addition, the environment around the process may be affected by lubricant spray and steam. Not only does this make manual inspection difficult, it can also affect electronic equipment and obscure camera visibility.

The primary purpose of surface inspection in the cold rolling mill is to look for any dents and scratches in the metals. It is important that any automated surface inspection system is able to distinguish between natural flatness issues and genuine dents. This is particularly challenging on lighter, final pass gauges in the region of 200 microns.

A further challenge faced by an automated system is installation and positioning. In a typical cold rolling mill, space is extremely limited, with very little room between the last mill stand, turndown roll, and mandrel where the coil is wound.

Finding the right point for effective, accurate surface inspection of the process requires precision equipment and a high level of applications knowledge and expertise.
AMETEK Surface Vision provides a customizable, modular inspection system for the cold rolling mill. Based around the SmartView® platform, this system is equipped with advanced LED illumination, highly sensitive line scan cameras, data capture computers and associated process control equipment, with powerful algorithms for detection and classification.

The advanced, compact LED lighting illuminates the material for inspection and also helps compensate for the influence of the surface flatness issues, while remaining sensitive to the real defects. This allows the line scan cameras to obtain high-resolution images for the best detection and classification of defects.

AMETEK Surface Vision has significant experience with the cold mill application, and has evaluated alternate camera focal points to find the optimum positions. Positioning the high-intensity lights correctly is also an essential part of the installation process.

One of the most revolutionary elements of the SmartView system for this application is the addition of streaming video. This provides photo-quality visualization of the metal surface, allowing the process engineer to inspect the product without having to manually reinspect the aluminum on another process line.

SmartView’s video is recorded at a resolution unmatched in the surface inspection industry. This same video is capable of being archived and then run back through the inspection system to produce an alternative inspection based on modified rules, thresholds and classification.

The SmartView system is fully modular and expandable. AMETEK Surface Vision can supply a solution that scans both sides of the metal, but because of the space constraints and decision to focus on a prime side, many customers find it more practical to scan a single side. This is a more compact solution and, since dents on one side are also visible on the other side, provides an effective inspection system.

AMETEK Surface Vision’s SmartView product allows customers to manage their data in an open SQL database, which can be used to port to their own process control and quality control management systems.

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KEY COMPONENTS OF THE SMARTVIEW SYSTEM

LINE SCAN CAMERAS
Provide ultra-high-resolution images of surface features and defects, which allows for excellent detection.

ADVANCED CLED (COMPACT LED) LIGHTS
Illuminate the material for inspection.

OPEN SQL DATABASE
For data integration with customers’ quality management system for full coil history from hot rolling, through cold rolling and coating to the slitting process.

SMARTLEARN CLASSIFICATION MANAGER
Multi-step classification software for product quality assessment. SmartLearn delivers unsurpassed accuracy in filtering out non-critical defects and classifying easily distinguishable defects in real time.

STREAMING VIDEO CONSOLE
Allows process engineers to review or re-run the coil in high resolution using the data stored on a 48-224-hour buffer.
AMETEK Surface Vision is the world leader in automated online surface inspection and monitoring solutions. Our broad product range is optimized for the monitoring and inspection of webs and surfaces, and for process surveillance applications.

The SmartView and SmartAdvisor® product lines deliver robust, flexible solutions to continuous production processes across a number of industries, with hundreds of customers and more than 2,500 installations worldwide.

Our systems have become vital to increasing efficiency, streamlining operations, improving product quality and reducing costs and waste in industrial processes. Manufacturers in the metals, paper, plastics and nonwovens industries rely on our solutions to detect surface flaws or defects, and optimize process efficiency, at their production facilities across the globe.

We continue to innovate, providing cutting-edge technologies and world-class technical support that delivers highly accurate defect data, high-definition video, intelligent grading, archiving and detailed reporting. Customers who use AMETEK Surface Vision’s services get the benefits of:

- Reduced operational costs
- Process optimization
- Reduced process upsets (breaks, wash-ups, etc.)
- Improved product quality
- Maximized yield
- More thorough and objective grading of material
- Detection, classification and visualization of defects
- Minimized need for manual inspections
- Inspection reports you need, in a form you can use

Based in Hayward, California, AMETEK Surface Vision has offices and sales representatives around the world. We are part of the Process and Analytical Instruments Division of AMETEK Inc., a leading global manufacturer of electronic instruments and electromechanical devices.