Laminação
Rolling
49º Seminário de Laminação - Processos e Produtos Laminados e Revestidos
49th Rolling Seminar - Processes, Rolled and Coated Products
ISSN 1983-4764

IMAGE PROCESSING APPLIED TO INCLUSION DETECTION RESULTS FOR TINPLATE APPLICATION[1]

Olivier Deschamps[2]
Laurent Dorel[2]
Zita Canalejo Catalan[3]
Philippe Piquemal[4]
Louis Satyanarayan[4]
Philippe Mouls[5]

Abstract
Presentation of Lamb Wave application together with signal processing (=SIAS) applied at ArcelorMittal Aviles (Spain) pickling line. The presentation covers the following topics: principle of lamb wave application, description of SIAS signal processing applied to lamb wave, results / benefits of the application at ArcelorMittal Aviles.
Key Words: Surface inspection; Surface quality; Inclusion; Steel tinplate.

[1] *Technical contribution to the 49th Rolling Seminar – Processes, Rolled and Coated Products, October, 22nd-25th, 2012, Vila Velha, ES, Brazil.*
[2] *Siemens VAI MT SAS – France*
[3] *ArcelorMittal Aviles – Spain*
[4] *ArcelorMittal R&D – France*
[5] *Siemens Ltda. - Brazil*

ISSN 1983-4764

1 INTRODUCTION

The quality standards in the sectors of the packaging becoming increasingly strict, it had become necessary to guarantee for the steel producers the inclusion cleanliness of rolled metal.
The ArcelorMittal group thus decided to develop equipment making it possible to control on line the internal quality of thin sheets: control by Lamb waves.
After validation by ArcelorMittal Research, the responsibility for industrialization was entrusted to the Siemens VAI Metals Technologies and Spie companies.
In order to benefit from the results as early as possible in the production route, the system is designed to be placed on the pickling line.
The system is composed of 3 parts:

- on line sensors (lamb wave)
- acquisition hardware, based on SIAS technology
- server for archiving , database.

The challenge of the installation at the pickling line had to be considered taking into account:

- the environment
- the line speed up to 600m/min
- 100% coil length inspection
- thickness up to 6mm.

2 INSTALLATION

The sensor is composed of an ultra sonic transducer which sends/receives echos through the strip. One wheel inspects half of the strip, so 2 wheels are necessary for a complete strip inspection. An overlap between the 2 wheels ensures that 100% of the strip width is covered.

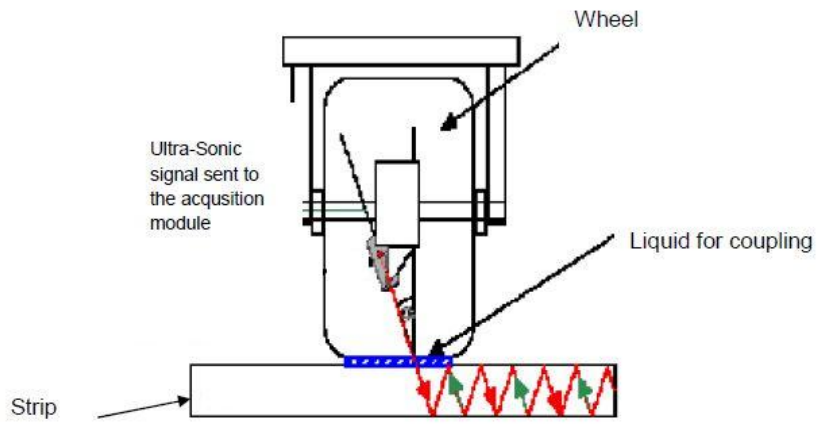


Figure 1: Sensor principle.

When there is no defect, the main echo received corresponds to the strip edge. When an inclusion passes under the wheel, an early echo (depending on the inclusion crossweb position) is detected.

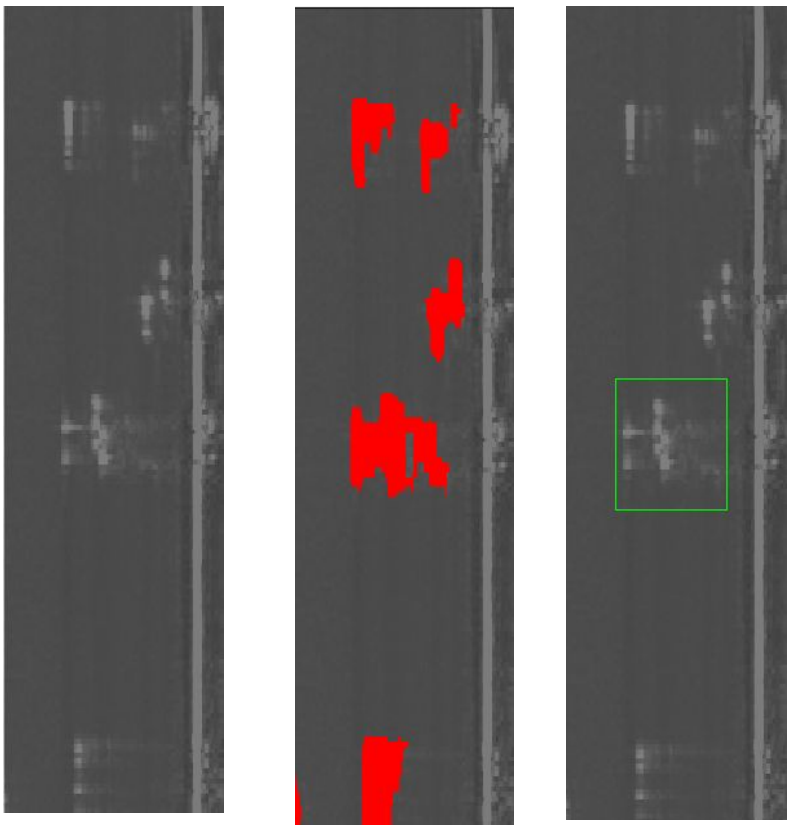
ISSN 1983-4764

Figure 2: Picture of the on-line system.

3 ACQUISITION PRINCIPLE

As it is being acquired, the image is “normalized” to eliminate the negative impact of both sensor-related (e.g. electronic noise) and product-related (e.g. product aspect variations) phenomena. Consequently, image processing is consistent and leads to an image that is free from external disturbances.
On the image, detection algorithms are applied: each pixel is analyzed to determine whether it is “suspect”. The algorithms consist of a combination of filtering and thresholds in real time and here again the system sensitivity is programmable and depends on product type.

ISSN 1983-4764



A fine inclusion near the edge

Detection result : Pixels above the tolerance threshold are highlighted

Localization forms an object with defined characteristics (size, location, shape etc.)

Figure 3: Image processing principle.

Furthermore, auto-adaptive algorithms have been introduced to cope with the increased variability observed in the surface texture within the same incoming steel grade, automatically adjusting the sensitivity to background noise, thus accelerating and simplifying the on-site tuning.

Each object image is then analyzed by software to identify which defect category it belongs to. This phase which consists in identifying detected objects is called classification. The SIROLL SIAS exclusive, patented classification method is a multi-stage approach for streamlined operation and maximum efficiency. It is fully traceable and highly accurate. Classification basically consists in comparing the newly detected flaw with a “knowledge base”, i.e. a defect library, a group of defect images assembled by Quality people that is typical of what can be seen on the line.

ISSN 1983-4764

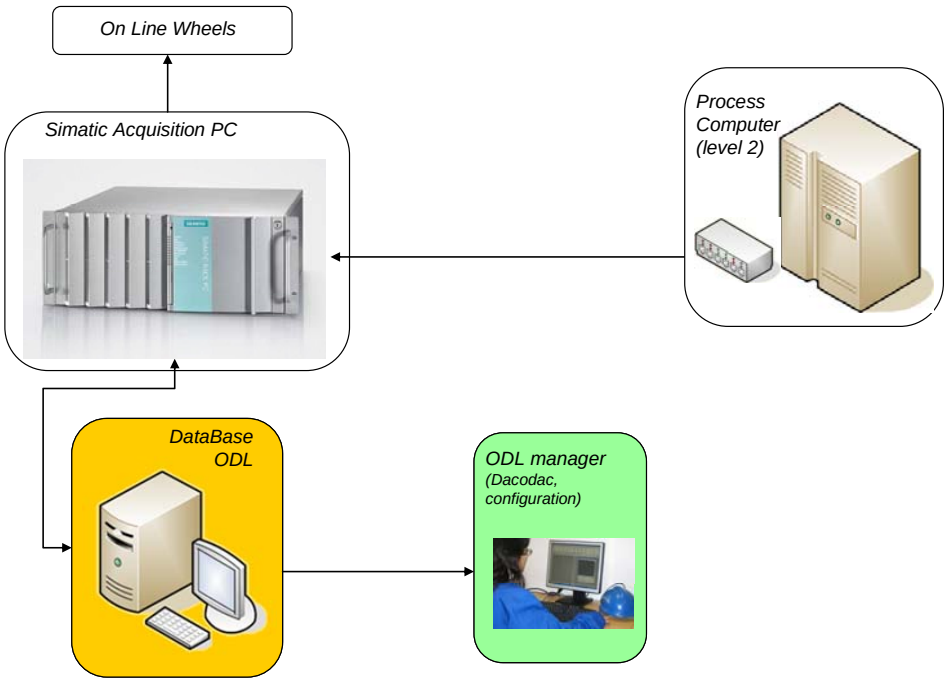


Figure 4: System Architecture

Inclusions are then analyzed with a “density analysis module” which allows to raise alarms based on the inclusions per meter square of product.
At any time it is possible to monitor the density of a particular defect class with a graph showing the density of that class. The ranges of the horizontal and vertical scales can be configured by the operator.

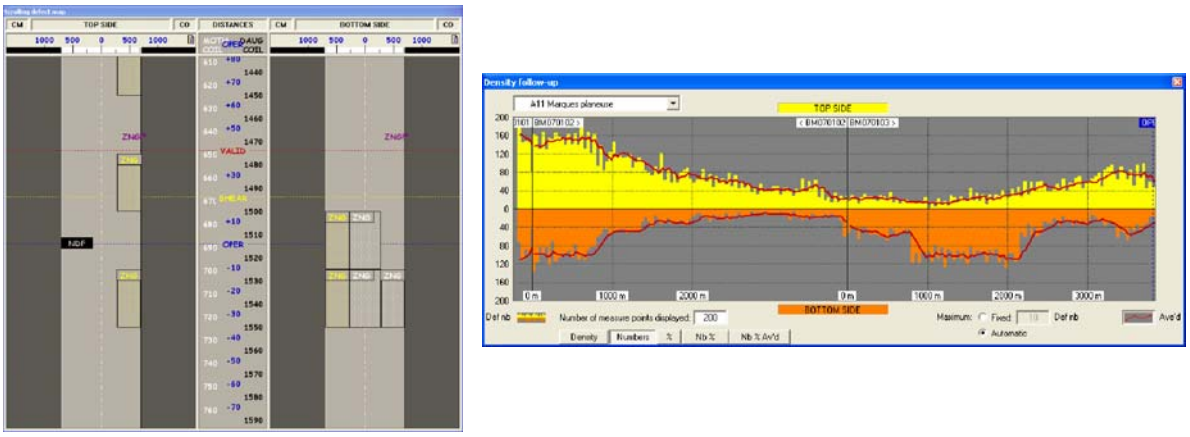


Figure 5: Screen Examples.

Siemens SIROLL SIAS system provides total traceability and monitoring of the inspection process, which is key to both high confidence in the results and Quality management (e.g. ISO) of the measurement.

4 RESULTS

The installation at ArcelorMittal Aviles was tuned in order to monitor 2 types of inclusions:

- “small inclusion”
- “big inclusion”.

ISSN 1983-4764

The criterion to differentiate both is based on geometrical data.
A third class has been introduced, which corresponds to false echo (ie noise from the sensor), but which is well differentiated from real inclusions after classification stage.
Some deep validation has been done , with correlation between lamb wave inspection, and inclusions seen on the downstream process (eg galvanizing line) using classical camera based inspection. Not all inclusions are visible on the downstream process, but where high number of inclusions where detected in the pickling line, corresponds to local detections of inclusions on the galvanizing line.

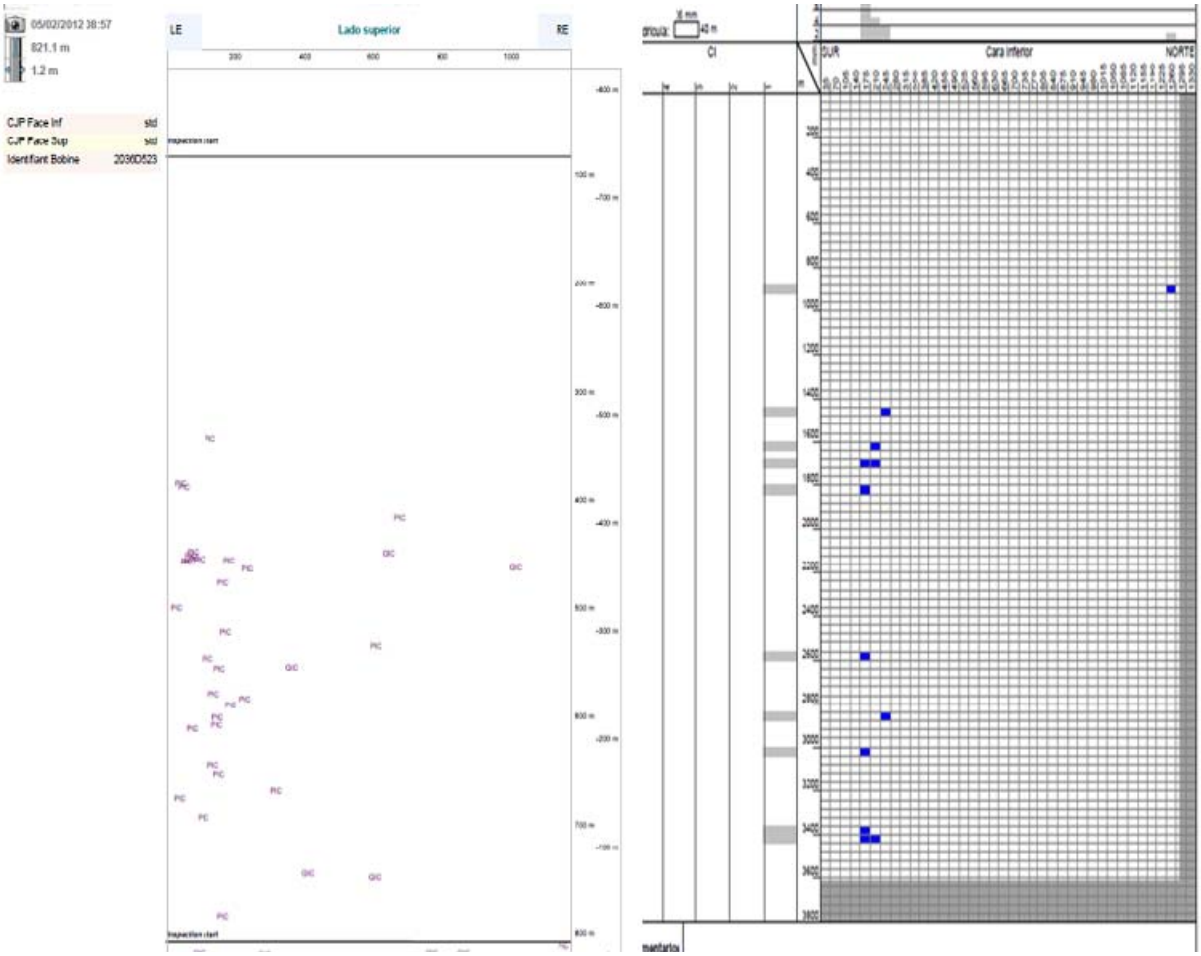


Figure 6: Correlation between lamb wave inspection and visual inspection

5 CONCLUSION

Within a few weeks, the preliminary results went beyond expectations. The system allows to detect and alert on products with inclusions. With an early product re-routing (repair/downgrade) , coils are not sent anymore to rolling and tinning lines. As a next stage, caster optimization will be done, by correlations between inclusions and casting parameters.
Also, coupling between lamb-waves and surface (camera based) inspection can be a next evolution.