

sensors positioned at the top side of the band. The sensor can be moved autonomously and measures the position of the second edge and therefore the band width, while the upper thickness sensor measures the first band edge.

This is how slitting lines are able to measure and report on the thickness and width of the entire band of any single strip. As well as being independent of the material and alloy, another important advantage of laser line sensors is the

stability of the measurements that can be gained from their high level of information density.

### More precision sensors

Micro-Epsilon offers reliable, high performance, unique solutions particularly when high precision measurement or inspection is required. The product range covers sensors for the measurement of displacement and dimension, sensors for IR temperature and colour measurement, as well as systems

for dimensional measurement and defect detection. Micro-Epsilon also presents a wide range of optical measurement technologies for displacement, distance and position which play an essential role in increasingly automated production and inspection processes. As well as the miniaturisation and increasing functionality of sensors, smooth process integration is also a decisive factor in highly automated industrial production environments.

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# Non-destructive material testing

The demands from the aerospace industry with respect to the quality of intermediates and pre-cut parts, as well as its documentation, are rising constantly.

Process chains subject to a variety of control mechanisms are required in order to meet these quality demands. Methods of non-destructive material testing (NDT) are also employed here. The need for comprehensive testing in accordance with internationally recognised standards, for large dimensions of the intermediates and for complete documentation, is driving the development towards ever more automated systems. These demands are perfect for HPI (High Performance Industrietechnik GmbH), headquartered in Ranshofen (Austria), as it can draw on many years of experience in serving customers worldwide with innovative ideas, concepts and systems.

Kamensk-Uralsky Metallurgical Works J.S.Co. (KUMZ) is one of the key enterprises of Kamensk-Uralsky in Sverdlovsk Oblast, Russia. KUMZ was founded especially for supplying the aviation industry with semi-finished products in aluminium and magnesium alloys. Currently, the plant produces aluminium alloy billets, forged and rolled plates, roll bond heat exchangers, extruded rods, bars, tubes, drill pipes, profiles, and die-forgings. In December 2011 KUMZ entered into contracts for the construction of a new rolling mill complex comprising cold rolling mill, hot rolling mill and heat treatment of sheets. Part of these future-oriented investments has been spent on conductivity measuring systems and facilities for the geometric measurement of aluminium plates supplied by HPI. These plates have widths of up to 4,200 mm, lengths of up to 33,000 mm and thicknesses in the range from 1 to 210 mm. The following section gives an overview of the technology and functioning of these systems.

### Geometry measurement

The geometric dimensions are recorded on a 35 metre long, exactly aligned measuring table on which the plate is measured contact-free by laser triangulation. As the measuring portal travels in the longitudinal direction of the plate, measured data are collected and processed in a high-speed controller. The length, width, squareness and flatness are displayed to the operator on the human-machine interface (HMI). The thickness of the plate is measured at a variety of freely selected points by means of mechanical sensors. Dimensional tolerances in



Conductivity measuring unit.



accordance with EN 485-3 or other comparable international standards can be stored and used for reference. After geometric measurement of the plate, its heat treatment state is evaluated by means of a conductivity test.

### Conductivity test

A roller table transports the aluminium plate through a stationary measuring unit in which the specific conductivity values are measured on the upper and lower sides of the plate using oscillating probes. During the conductivity measurement using eddy currents, a coil creates an alternating magnetic field which induces a voltage in the material being examined. Depending on the specific conductivity of this material, eddy currents are generated in the material, which again create a magnetic field. According to Lenz's Law, this magnetic field opposes the transmitting field and is measured using a second coil. The amplitude and phase angle of the received signal are important here for assessing the conductivity. Due to the skin effect, the eddy currents are created near the



HPI geometric measuring equipment.

surface of the plate. The higher the frequency of the magnetic field, the lower the penetration depth into the material.

Conductivity is a physical parameter which reflects the ability of a material to conduct electricity. The conductivity is the constant of proportionality between the current density and the electric field strength. The Greek lower-case letter sigma is very frequently used as the formula symbol. The conductivity proper is frequently expressed in Siemens per metre (S/m), i.e. A/(Vm), derived from the SI units. As aluminium alloys have very good conductivity, the value range mS/m is used for all typical applications. A further possibility for expressing the value is the use of the International Copper Standard. Here the value is expressed as a percentage of the conductivity of pure, heat-treated copper, hence the designation percent of the International Annealed Copper Standards, or in abbreviated form: %IACS.

During laboratory applications it is relatively easy to control physically induced factors such as the lift-off effect, edge effect and the temperature influence during measurement. Under the rugged conditions of an industrial application, however, this represents a very great challenge. The measurement programmes can be predefined for each plate, taking as reference the internationally recognised standards ASTM E 1004-02, MIL STD-1537C, EN2004-1 and AMS 2772F, and the customer-specific testing specifications of the aerospace industry.

### **Plate marking**

After conductivity measurement, the plate is transported through a marking portal. Here ink-jet heads mark the upper side of the plate

using the two variants defined in the standard ASTM B-666 or ASTM B-666 M-01. With plate widths of up to 2,000 mm, the desired text is printed on the plate in lines with a line spacing of 150 mm. On plates with widths over 2,000 mm, the text is printed in two lines around the circumference. Installed at the end of the line is a needle marking unit which, depending on the plate thickness, marks the upper side or the end face of the plate with a predetermined text. Depending on the specifications, this text can be generated from a combination of plate identification number, date and other details.

### **Data processing**

All the necessary basic data, such as the unambiguous plate identification number and the testing specifications to be observed, are

transmitted to the system by a superordinate Level 3 system, the Manufacturing Execution System (MES). In the opposite direction, all the information on the plate, starting with the measurement data, calibration data through to the marking options for the ink-jet marking and needle marking, is displayed and stored on the HMI and transmitted to the Level 3 system. Only in this way can complete documentation of the test be guaranteed.

HPI supplies plants and systems for the aluminium industry, such as horizontal casters, continuous homogenising plants, sawing and stacking plants, ultrasonic testing systems and the measuring and testing facilities described above. Customers worldwide have been relying on products from HPI for more than 25 years.

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