Automatische Prüfung von Fügeverbindungen in der Automobilindustrie

Dr.-Ing. Christoph Döllinger, Thermosensorik GmbH

Outline

- Thermosensorik GmbH in two slides
- Principle of Heat-Flux-Thermography
- Inspection of Laser Welds and Spot Welds
- Inspection System in Automotive Industrie
Thermosensorik: 9 Years Success in Infrared Technology

- Founded Oktober 1998
- Spin-off of the University of Erlangen-Nürnberg
- Based in Erlangen
- 30+ Employees
- 100+ Thermosensorik-Systems in the Market
- Investment Closing May 2006
  Siemens Venture Capital
  Siemens Technology Accelerator

Products and Activity Focus

- Industry Equipment:
  e.g. Turbine Blade Test System
- Laboratory System for NDT
- High Sensitive Infrared Cameras, Lenses and Accessoires
- Lenses and Accessoires
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Thermosensorik: “Heat“ becomes visible

Hand on paper ...

„Nodes and Crosses“
Principle of Heat-Flux-Thermography

Creation of Temperature Gradient → Heat Flux
IR-Camera: Detection of Surface Temperature versus Time
IR-Video → Result Picture (Precalculation)
Automated Defect Detection

Thermosensorik: “Heat” becomes Visible

Heat Source:
Human Hand

Sensor:
IR-Camera

Sample:
Writing pad with a logo-sticker on the third page

The Hidden Logo …
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Need for NDT ... Laser Welding

Presented by Auto 5000 at EALA '07

To be replaced ...
Chisle- and Soft-Chisle-Test
Need for NDT ... Spot Welding

- High Tensile Steel and US-NDT ???
- Cost for Man-Power
- Material Costs - Reduction of Destructive Testing

Heat Flux Thermography: Principle of Laser Weld Inspection ...

Test Setup

Photograph

IR-Image out of Sequence
Typical Laser Weld defects

ROI (LINE) - Line Profile

Pixel No.

0

-200

-400

-600

-800

-1000

-1200

ROI (LINE) - Line Profile

Pixel No.

0

-100

-200

-300

-400

-500

-600

-700

-800

-900

-1000

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„Falscher Freund“
No Welding!
Typical Laser Weld defects

Corrosion Problems caused by ...

Result 1: „Falsche Freunde“

Result 2: „Einschüsse“
Automated Laser Weld Inspection

- IR-Image
- Evaluation-Image
- Parameter Setting
Heat Flux Thermography: Principle of Spot Weld Inspection...

Photograph

IR-Image out of Sequence

Test Setup

Dealing with...

<table>
<thead>
<tr>
<th>Spot Weld Types</th>
<th>Defect Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/3-metal-sheet combinations</td>
<td>Missing spot weld</td>
</tr>
<tr>
<td>Different Materials</td>
<td>Open spot weld</td>
</tr>
<tr>
<td>(22MnB5, H340LAD + Z, H220Y, H320LA,</td>
<td>Open cavity</td>
</tr>
<tr>
<td>...)</td>
<td>Burn through</td>
</tr>
<tr>
<td>Coatings (electrolytically zinccoated</td>
<td>Brazed joint „Glued Weld“</td>
</tr>
<tr>
<td>, firezinccoated, organic coating,</td>
<td>Spot weld in wrong position</td>
</tr>
<tr>
<td>finealuminated etc.)</td>
<td>Indent</td>
</tr>
<tr>
<td>Thickness and Total Thickness</td>
<td>Cavity</td>
</tr>
<tr>
<td>metal sheet thickness 0.6/0.8 - 3 mm</td>
<td>Small Lens</td>
</tr>
<tr>
<td></td>
<td>Surface crack</td>
</tr>
</tbody>
</table>

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Spot Weld Inspection Software

Parameterization once ...

Set ROI
Set Parameter per Spot Weld multiple per frame

Automated Inspection
Spot Weld Inspection Software
Spot Weld Inspection Software: Results

Test program / Robot-Position / Nr. Spot Weld

Code for Defect Type

Lens Diameter in mm

Dealing with ...

Spot Weld Types
- 2/3-metal-sheet combinations
- Different Materials (22MnB5, H340LAD + Z, H220Y, H320LA, ...)
- Coatings (electrolytically zinc-coated, fire-zinc-coated, organic coating, fine-aluminated, etc.)
- Thickness and Total Thickness (metal sheet thickness 0.6/0.8 - 3 mm)

Defect Types
- Missing spot weld
- Open spot weld
- Open cavity
- Burn through
- Brazed joint „Glued Weld“
- Spot weld in wrong position
- Indent
- Cavity
- Small Lens
- Surface crack
Self-Calibration-Unit

Automated Self-Calibration-Unit for Robot based Inspection Systems
... to calculate from „pixels“ to „mm“ ...

Typical Results:
Lens Diameter of different body side panels

Spot Weld Diameter [normed to min. accepted diam.]
Reproducibility Spot Weld Inspection System

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Testing of Laser Welds

Customer: Auto 5000
Wolfsburg

Highlights: First Heat Flux Thermography System with two Cooperating Robots for the Inspection of Laser Welding in Automotive Industry, In Operation since early 2005

Main components of a Spot/Laser Weld Inspection System

- Two cooperating Robots with 7 axis each
- Robot with Flash-Unit for industrial use
- Robot with IR-Camera
- Sampleholder
- Typical Sample: Sidepanel of a car body
Main components of a Spot/Laser Weld Inspection System

Benefit ...

Reduction of quality control costs by application of thermography

Auto 5000 / Volkswagen statement at EALA Jan 2007
2007: Laser and Spot Weld Inspection
Customer: Auto 5000 Wolfsburg

Highlights:
First Thermosensorik Inspection System in Production which combines Laser and Spot Weld Inspection

- Flashing 20 ms
- Measurement time 300-600 ms
- Robot movement 3-5 sec
- 2-4 Spot Welds in one shot
- Calculations during robot movement
100% In-Line Inspection versus flexible NDT-Station

100% In-Line Inspection

NDT Station

Summary Weld Inspection with Heat Flux Thermography

- Non Contact Method
- Now Fully Automated (non subjective result, less labour cost, less training cost)
- One Dimension more information compared – $2\frac{1}{2}$ D
- Reproducible and Accurate to at least +/- 0.5 mm for lens diameter
- Fast: 36 Spots per Minute (multiple spot weld per frame – mostly 2-4, 1 frame every 3-5 Sec.)
- Only one Sensor (independent from Spot Weld Size)
- Works with upcoming High Tensile Steel
- Standard Interface: Interbus/Profibus
- Works with all Robots