Theme: Performance & Process Improvement

LASER WELDING:
A New Assembling Method for a Production Benefit
Positions of the LASER Welding Assembly

Embrio

- Over-Mold
- DSI
- DRI
- LASER

Mature

- Adhesion
- Ultrasonic Spin
- Snap-fit
- Bolt

Technology

Weight Reduction

Module

Integration

Total Cost Reduction

DSI, DRI
LASER Welding Summary

UV
380nm
Visible
780nm
Near IR
約0.7〜1.5μm
Mid IR
約1.5〜5.6μm
Far IR
約5.6〜1000μm
CO₂
10μm

Diode Laser
800〜950nm
Nd:YAG
1.06μm

Part’s move
Simultaneous multi-head
Scanning mirror
Special optic
Rapid multi-scanning
LASER Welding Principle

- LASER
- Surface Reflection Reflecting Energy
- Clamping Pressure
- Transmissive Scattering Energy
- Absorb Absorbed Energy

Power / Speed
Focus Diameter
Material
Part Design
Benefits of LASER Welding Assembly

- Clean  no flash/no bars
- Fast  no holding cycle time
- Strong  cross link of GF at joint surface
- Inexpensive  Facility/total cycle
Comparison 3 methods Welding Time •Burst Strength

- PA6 30%GR
- PA66 30%GR
- PET GR (exp.)
- UR PA66
- HTN 35%GR

- No flash
- Less facility cost

Break at typical area Not a joint

Dupont
Comparative Look; cross sectional observation

Orbital vib. welding

Linear Vibration Welding

Laser Welding

Ultrasonic welding

Adhesion • Seal joint
### Comparison with the other assy. methods

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<th>Bolting</th>
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<th>Hot Plate</th>
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<td>□ (weld time)</td>
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Confirm Laser welding technology as a production method
Considerations for polymer laser welding optimization

• **Materials**
  – Transmittance: Polymer • Pigment • Additives
  – Absorbent: Polymer • Heat gen./melt • Pigment

• **Design**
  – Wall thickness • Basic part geom • Joint design

• **Molding**
  – Warpage/Sink mark

• **Welding process**
  – Power • Speed • Cycle time • Focus spot
Transmittance & Absorbent relation between the polymer & Laser light

Transmittance vs. Wavelength (nm)

- PA 6
- POM
- PBT
- PC
- LD (800~950nm)
- YAG Laser (1064nm)
- typ. BK
Material / Wall Thickness & Transmittance

- Zytel® PA66 UR
- Zytel® PA6 GR
- Delrin® POM
- Crastin® GRPBT

(@ 940nm)
Polymer Laser Welding Optimization - Laser Power & Irradiation Time

- Surface degradation
- Void
- Carbonized

Adequate Adequate Welding Zone

- No melt

Laser Irradiation Time

Laser Power
Polymer Laser Welding Optimization - Productivity Speed & Power

(Zytel®HTN51G35HSL)
Polymer Laser Welding Optimization - Mn

HTN51G35HSL NC + BK (2mm ovlp TP)
Polymer Laser Welding Optimization - Absorbent material

- Process Window
Polymer Laser Welding Optimization - Moldability

![Graph showing the retention of transmittance (%)](image-url)

- Laser Transmittant BK
- Dev’t grade
- Typ. grade

Retention of transmittance (%) vs. H.U.T (min)
Polymer Laser Welding Optimization - Process Easiness

Before optimization

After optimization

Weld strength vs. Scanning speed
**LASER Welding Assembly - Case Study**

**Door Lock actuator**
- Customer: Hella
- Zytel® 73G15 NC
- Minlon®FE260001BK

**Camshaft position sensor**
- Customer: Delphi
- Zytel® LT 74G33HSL BK
- Zytel® 74G33 HSL BK

**Leakage Test Sensor**
- Customer: Bosch
- Crastin® SK603 NC
- Crastin® SK603 BK
LASER Welding Assembly - Case Study

**Gearshift housing**
Daimler Chrysler
Zytel® 70G30 NC
Zytel® 70G30 BK

**Trap Canister**
ASIAN Kogyo
Zytel® 103FHS NC
Zytel® FE110003 BK

Cost reduction on production (faster production cycle),
More design freedom, precise positioning, no flash
Development Support As a Total Solution

- DESIGN/CAE support for proposed basic geometry
  - minimize mold deformation & sink mark
- Propose adequate material selection
  - Including optimized pigment and heat stabilized
- Collaborate with system supplier & pigment supplier
- Development support for production facilities
- Development support by utilizing various TP and co-relate to the real applications
- Total development coordination for on-line monitoring & quality assurance
**EP Material & LASER welding**

- **PA**
  - LASER Weldable
  - NC Possible to use as Transmittance side
  - BK Possible to use as Absorbent side

- **POM**
  - LASER Weldable
  - NC Possible to use as Transmittance side
  - BK Possible to use as Absorbent side

- **PET/PBT/PCT**
  - LASER Weldable but, difficult than PA/POM
  - NC Possible to use as Transmittance side
  - BK Possible to use as Absorbent side

- **MR**
  - No transmittance, cannot use T side
  - BK Possible to use as Absorbent side

- **FR**
  - No transmittance (some exceptions)

- **LCP**
  - No transmittance, cannot use T side
  - NC/WT Possible to use as Transmittance side
  - BK Possible to use as Absorbent side

- **GF/Impact resistance**
  - LASER Weldable
  - but, PBT/PET is rather difficult than PA/POM
Du Pont various test pieces

Box: warp/corner Burst/tensile
Sphere: Burst
T-joint Tensile
overlap Shear

“Koma” Burst
Pure tensile
Global Technical Link & technical support
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