SHEET-BULK FORMING AND JOINING
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Introduction

What is sheet-bulk forming?

A new manufacturing technology in which conventional sheet and bulk forming processes are combined to plastically deform sheets and plates with intended three dimensional material flow.
Sheet-bulk forming

Which are the main advantages?

- Compact construction with integration of multiple functions in single components
- Lightweight design
- Increase of energy and material efficiency
- Combination of sheet and bulk forming operations in progressive tool systems

Typical challenges

Other examples
Sheet-bulk forming

*Flexible SBF laboratory tool system*

Representative unit cell concept
Sheet-bulk forming

Typical parts

Thickening

Local thickening

Injection
Why sandwich composites?

- High structural rigidity;
- Low weight;
- Thermal, noise and vibration insulation

The weight reduction in comparison with steel blanks with the same bending stiffness is up to 40%  
(ThyssenKrupp, 2014)
Sheet-bulk & composites

Major limitations

Costs associated with the materials and processes, namely to the necessity of joining parts made from sandwich composites with other adjoining components.

There is a need to develop new, less expensive, joining processes to make the use of metal-polymer sandwich composites more affordable and widespread in industry.
Sheet-bulk joining

Technologies for joining metal-polymer sandwich composites

- Adhesive bonding;
- Spot welding
- Mechanical fastening or riveting;
- Joining by forming

Joining by forming is limited to table-top and roller hemming (ThyssenKrupp, 2014) and its industrialization is complex and costly, preventing its use in small batch applications.
Sheet-bulk joining

New sheet-bulk joining technology to assemble metal-polymer sandwich composites
Sheet-bulk joining

Fabrication of lightweight structural panels

Potential application: floor of vehicles
Sheet-bulk joining

*Application of mortise-and-tenon joints in crash boxes*

How sheet-bulk joining can successfully replace resistance spot welding in critical security parts of automotive

*High strength low alloy steel (HSLA 340) with 1 mm thickness and 7 µm thickness galvanized coating*
Sheet-bulk joining

Application of mortise-and-tenon joints in crash boxes

Crash boxes with ‘mortise-and-tenon’ joints can absorb the same energy and avoid problems related to the utilization of formed panels made from dissimilar materials with different thicknesses due to residual stresses induced by resistance spot-welding.
Sheet-bulk joining

Fixing metal-polymer sandwich composite panels to tubes

Looking beyond conventional technologies to assemble sandwich composite panels to tubes
Sheet-bulk joining

Fixing metal-polymer sandwich composite panels to tubes
Sheet-bulk joining

*Producing lap joints in sheets or plates*

Current technologies to assemble components & body-in-white structures:

- Resistance spot welding
- Self-pierce riveting
- Clinching
- Adhesive bonding

**Main specifications for a new technology:**

- Room temperature;
- No surface preparation;
- Dissimilar materials;
- No addition materials;
- Strong joints;
- Hermetic joints;
- No springback problems;
- No protrusions – aesthetics;
A new alternative sheet bulk joining technology

Produces lap joints in metal sheets by combining partial cutting and bending with mechanical interlocking by sheet-bulk compression of tabs in the direction perpendicular to thickness.
Sheet-bulk joining

A new alternative sheet bulk joining technology
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