MatchID
Metrology beyond colors

KU LEUVEN

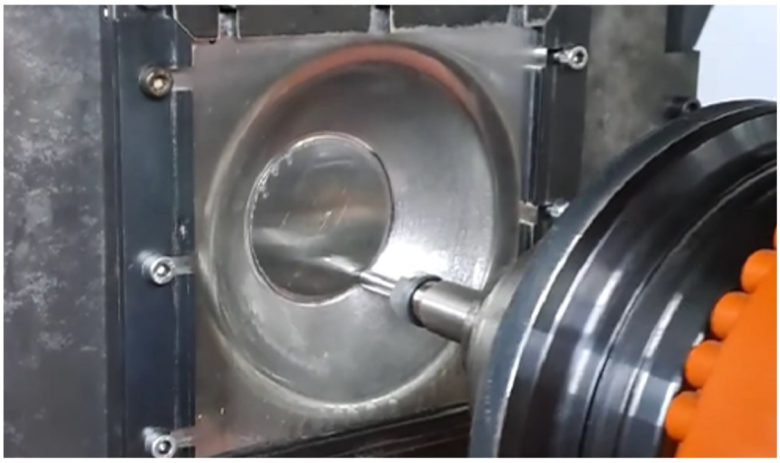
Application Note

Single Point Incremental Sheet Forming

Case Description

KU Leuven Manufacturing Processes and Systems uses MatchID DIC to determine thickness variations in a single point incremental sheet forming process (SPIF).

SPIF indents a metal sheet along an incremental contour path to generate a predetermined shape. The evolving geometry might be subject to specular reflection hereby hampering the DIC correlation process. By incorporating polarizers on both lenses and beam-angled light, flat illumination is obtained and optimum images for a DIC analysis are guaranteed. The induced biaxial strains and derived thickness are retrieved with a relative error of ~1% w.r.t. manual measurements, hereby relying on MatchID' s performance analysis module for optimal analysis parameters.



Experimental Setup

- ✓ **Cameras:** 2 x Allied Vision Mako G-507B
- ✓ **Light Source:** DC-LED Polarized lights with adjustable beam angle
- ✓ **Acquisition Speed:** 1 Hz
- ✓ **Field of View:** ~200mm x 200mm

Analysis

- ✓ **Calibration:** 50 calibration images
- ✓ **Noise**: evaluation via static images
- ✓ **Signal to Noise:** determine optimum DIC settings
- ✓ **Type:** Stereo DIC

Results

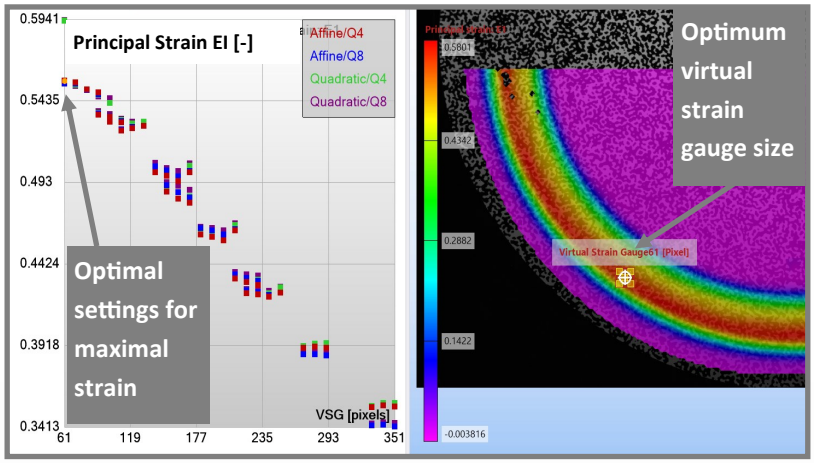
- ✓ Forming process motion and final shape
- ✓ Full-field strain data
- ✓ **Thickness reduction** by relying on volume conservation

- ✓ **Polarized lenses and beam-angled LED** lights to reduce specular reflection
- ✓ Powerful **performance analysis module** determines optimized DIC settings
- ✓ **Integrated scripting** for extended results analysis
- ✓ Detailed report generation

Why MatchID

Optimized Processing Settings

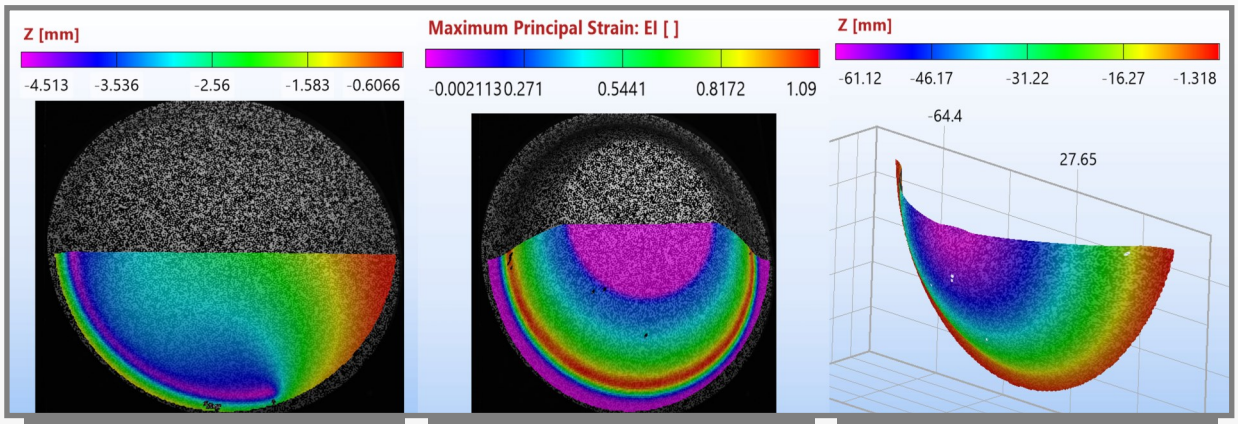
The incremental forming of the aluminum sheet results in biaxial strains by the load of the forming pin. The aim of the experiment is to estimate the thickness of the sheet relying on surface strains with the assumption of volume conservation. In order to accurately measure surface strains, and accordingly thickness, the performance analysis module is used to determine the DIC settings that yield an optimum signal to noise ratio.



In this study, the aim is to retrieve the DIC settings that generate a maximum and converged strain value. The full-field plot shows the size of the corresponding virtual strain gauge, indicating the actual size of the adopted smoothing area.

Transition and Final Shape

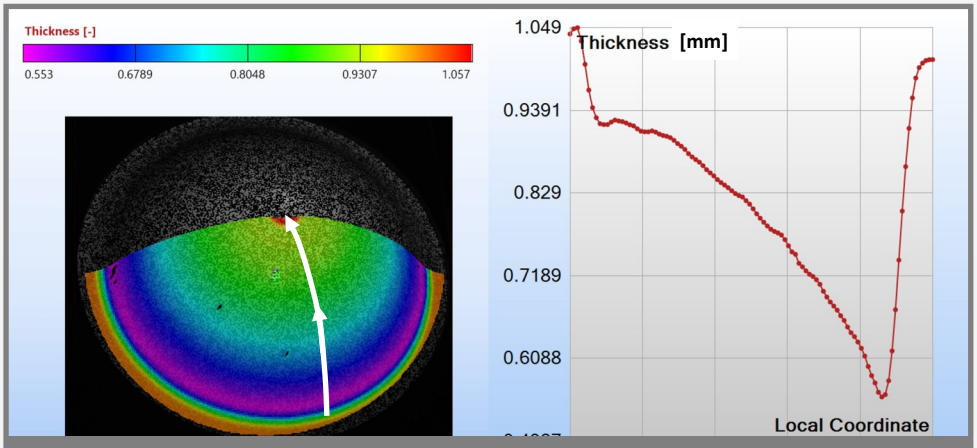
SPIF indents a metal sheet along an incremental contour path to generate a predetermined shape. During this incremental forming process Stereo DIC can measure the evolving shape and the induced strain gradients.



Pin motion at the initial steps | Strains at an intermediate step | Final shape

Thickness Evaluation

The resulting strain components can be used to derive the thickness distribution of the field by relying on volume conservation. This derivation is made readily available via MatchID's AppStore and can be added to your package via a dedicated plugin. Once the thickness field is obtained, profile sketches are extracted to compare different materials and forming processes. In the past, this procedure was a manual one. Hence, the SPIF procedure can be optimized from a an automated full-field perspective by benchmarking with simulations.



Thickness [mm] full-field plot and profile along the indicated line