Application Example: Sheet Metal Forming

Modern measuring tools in stamping applications for complex and simple parts

Measuring Systems: ARGUS
Keywords: Tool optimization

ARGUS measures and visualizes the quality and degree of the stamping process on sheet metal. For the ARGUS measurement of a simple stamped sheet metal part, only few images are taken, but ARGUS also accepts and integrates many images into a virtual assembly and is therefore able to measure the complete range of products used in sheet metal stamping.

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Sheet Metal Forming / Forming Analysis

Modern measuring tools in stamping applications for complex and simple parts

Measuring Systems: ARGUS
Keywords: Tool optimization

ARGUS measures and visualizes the quality and degree of the stamping process on sheet metal.
For the measurement, the sheet is marked with a regular grid of dots, using chemical etching, laser marking or other marking techniques. Then, the sheet is stamped. For the measurement, one or two scale bars and some coded markers are placed directly on the part or close around it. Then, a digital CCD camera is used, with real time viewing of the actual view on the PC, to take shots from different viewing directions.

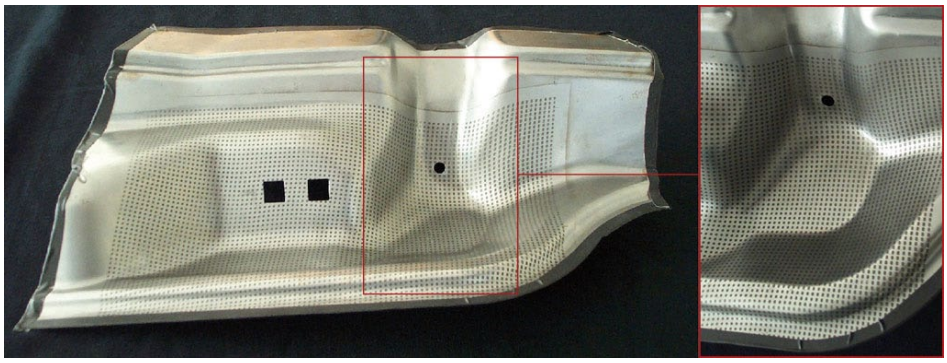


Fig. 1: Sheet metal part with etched dots after stamping

After the acquisition of the images, ARGUS will define in each image the exact center point of all marked dots. Then, using photogrammetry techniques, the images are virtually assembled to represent the object. From this virtual assembly, the center of each marked dot on the object is defined in real 3D coordinates. These calculated 3D points define the exact form of the stamped sheet part. From the local distortion of the regular grid pattern which was applied on the flat sheet metal, the local strain introduced by the stamping process is calculated in many thousand local data points. These strain values which usually are the major and minor strain as well as the thickness reduction define the degree of the forming. The values are usually graphically displayed and validated in relation to the Forming Limit Curve (FLC) of the selected material or in relation to the maximal allowed reduction of the sheet thickness by the stamping process. The accuracy of the measured strain values is better than +/- 0.5%, while showing a good optical quality of the dot pattern after the stamping process and thus also allows for performing hardening investigations on parts with a low forming degree (hood, roof).

For the ARGUS measurement of a simple stamped sheet metal part, only few images are taken and a typical measurement to validate the stamping process is finished in a few minutes.

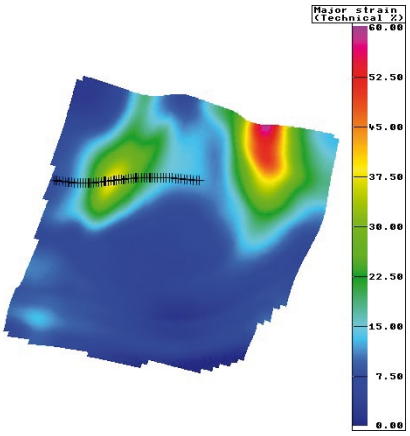


Fig. 2: Color plot of the major strain distribution

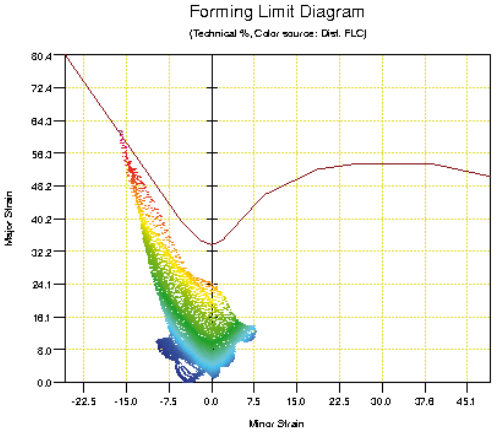


Fig. 3: Forming limit diagram with measurement data and forming limit curve

A sheet metal part with typically 25 x 25 cm (10 inch) size and 8 cm depth was captured with seven images. Calculated are typically 2'000 etched points on the object surface. The complete measurement, with the setup of the part, the image acquisition, the calculation of the centers of the dots in the images and the actual 3D positions of these dots on the stamped part, the calculation of the pattern distortion (local strain) up to the calculation of the graphical display is completed in less than five minutes.

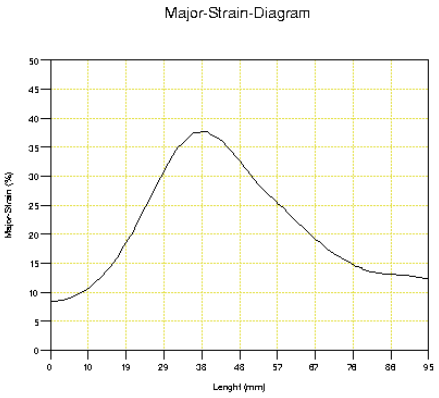


Fig. 4: Major strain in the section which is indicated in Fig. 2

ARGUS determines the dot markers on the deformed sheet metal by means of individual images which were recorded by a camera from different directions. Therefore, the ARGUS system is portable and versatile. Thus, sheet metals can be measured in their deep drawing mold and all around measurements as well as the measurement of large parts can easily be carried out.

To record the cupping test of a chromium steel sheet metal having a thickness of 1.4 mm, 16 images were taken (8 images during one rotation of the object on the rotation table, two times with different camera positions). The current shape of the component and the local deformations due to the shaping process are calculated.

All relevant characteristics, including iso lines, strain directions and thickness reduction (in percent) are displayed. If the thickness of the sheet metal is known, the deformation values can be converted to the neutral fiber, and if information is available on the yield point or the FLD diagram, the "distance" to the critical deformation can be defined.

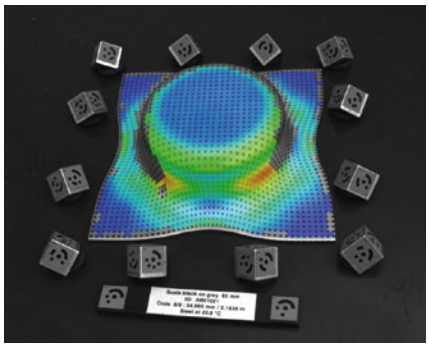


Fig. 5: Cupping tool with measuring data overlay (major strain)

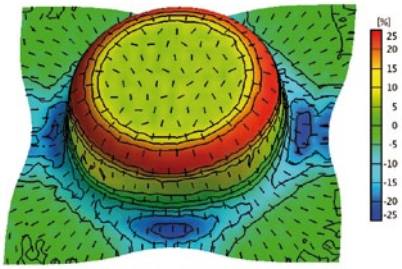


Fig. 6: 3D measuring data displayed as thickness reduction with iso lines and direction information of major strain

To assess the shaping process in a multistage tool, the different shaping stages can be recorded and evaluated in a common project. The deformation relations in each individual stage and the complete deformation can be measured, graphically visualized and evaluated.

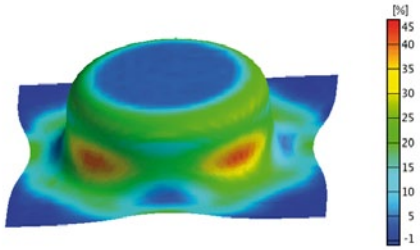
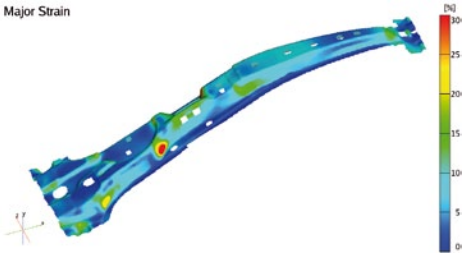


Fig. 7: 3D measuring data (major strain)

To verify the process and for measurements of highest precision, the sheet metal with the dot pattern can be measured before and after the shaping process. The analysis of the images that were recorded prior to the shaping process provides for measuring irregularities in the raster and to visualize them graphically. By assigning the measurement before the shaping to the measurement after the shaping, the raster errors can be eliminated in the measuring results.

ARGUS is also able to measure very large and complex sheet metal parts because of the integration of images from different views.



Figs. 8+9: B-Pilar and color plot of the major strain distribution of the B-pillar

Shown is the stamping evaluation of a complete B pillar with a starting thickness of 0.9 mm, typically 1.1 meter length and 0.35 meter width, which was provided by Salzgitter AG. The applied dot pattern was etched with a dot spacing of 3 mm. For the complete measurement 47 images were taken using the ARGUS 4M system. From these images 28,700 measuring points were defined on the part in a computation time of 6 minutes on a 64 bit PC.

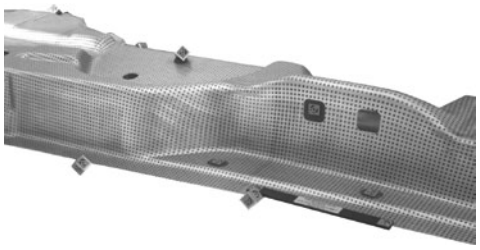


Fig. 10: Detailed view of the B-pillar

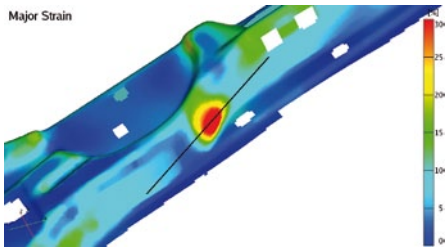


Fig. 11: Detailed view of the B-pillar: major strain distribution

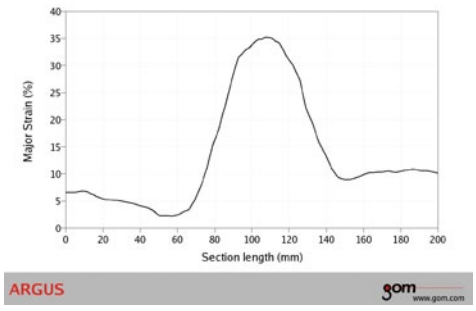


Fig. 12: Section as given in Fig. 11 with the corresponding strain values

GOM measurement systems are used daily in many steel and aluminum producing companies, in automotive enterprises and their suppliers. The systems deliver exact and relevant data of the quality and degree of the stamping process. The ARGUS system is used on the shop floor and in research applications, for simple parts as well as for very complex and large stamping parts.

By courtesy of Salzgitter AG and the University of Aachen IBF.