Project name:	**Residual Stress Analysis on Deep Drawn Duplex Steel Structures**

Beamtime Report

12.12.2013 - 16.12.2013 *(Date of the report: 03.04.2014)*

General information

Name of the rapporteur	**Name of the rapporteur's organisation**
Boel Wadman	Swerea IVF
Type of research (nanotechnology/health care/chemistry etc.)	**Name of the research facility**
Material Science and Engineering	Helmholtz-Zentrum Berlin, Synchrotron Radiation Facility BESSY II, EDDI - Energy Dispersive Diffraction Station
Date of the measurement, duration	**Location of the event**
12.12.2013, 4 days	Berlin
Facility personnel participating in the measurement	
Dr. Manuela Klaus and Dr. Daniel Apel	

Description of the project

Research description (short summary as written in the application)
The sheet metal forming group at Swerea IVF studies the influence of the forming process on product properties, where one aspect is geometric deviation caused by the residual stresses introduced during forming. We are currently investigating the influence of different forming parameters on residual stresses in high strength steel together with steel and automotive companies. The goal is to design forming processes by numerical simulations. These numerical predictions need to be verified, and we have obtained good correlations with surface residual stress measurements with conventional lab XRD and FE analysis. We now apply for beam time to measure through the sheet thickness which could not be done by lab XRD without etching the samples. Our main objective is to perform non destructive residual stress profile measurements through the sheet thickness. We therefore apply for time to perform measurement by usage of synchrotron diffraction with suitable X-ray source. The steels in question are martensitic-ferritic or martensitic-austenitic duplex steels, with thickness 1 – 1.5 mm.
Summary of activities (experiments performed, beamtime used, preliminary overview of results, next steps and other relevant information)
Two deep drawn duplex steel cups were investigated with respect to their residual stress depth distributions in the axial direction s_{ax}. The samples are characterized as follows: • sample 4: 100% speed, 200kN BH force

Part-financed by the European Union

• sample 15: 3% speed, 200 kN BH force.

The measurements were performed on the positions marked by sample provider. The experimental setup and the diffraction geometry as well as the measurement direction is illustrated by the photographs in Figure 1.1. The investigations were performed with respect to the axial residual stress component σ_{ax}.

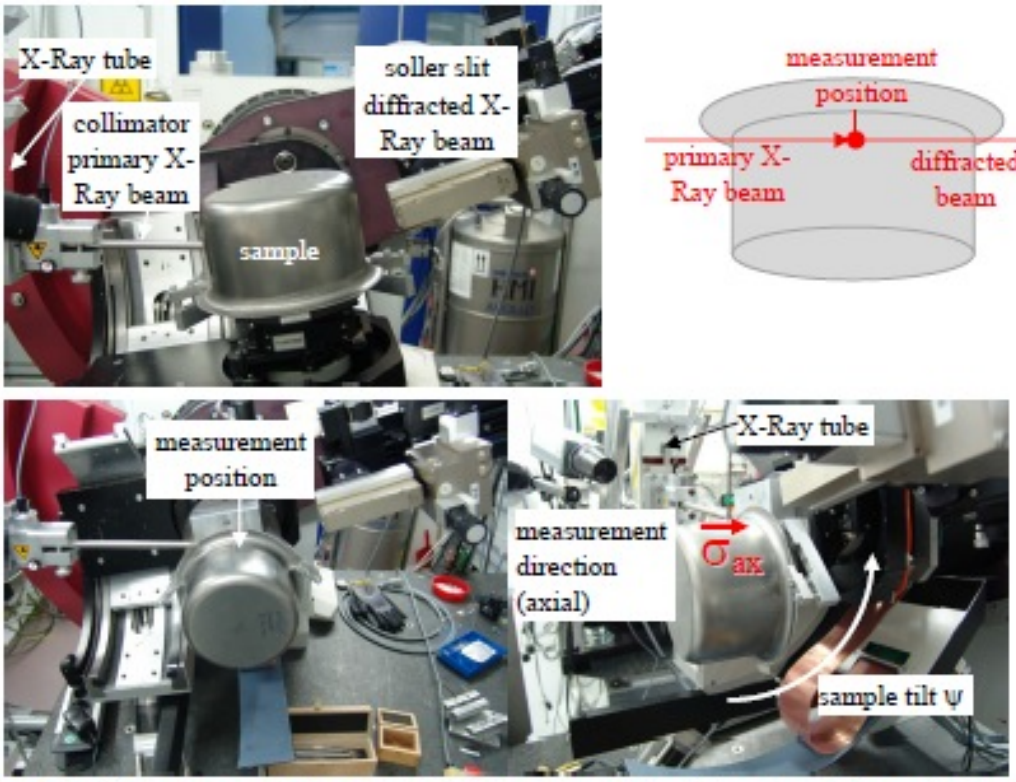


Fig. 1.1 The experimental setup and the diffraction geometry, top left: sample position $\psi = 90°$ and bottom: $\psi = 0°$, top right: schematic drawing.

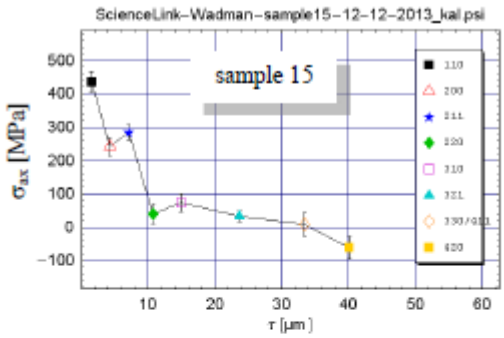
The EDDY beamline at the Helmholz-Zentrum Berlin was used in the energy-dispersive diffraction mode, with the following parameters:

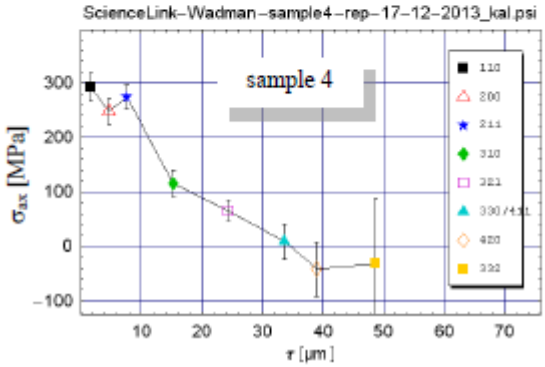
Table 4.1 Experimental parameters.

Radiation:	white spectrum of the bremsstrahlung of a W-X-Ray tube, 60 kV / 40 mA (long fine focus)
Optical elements:	• primary beam: collimator ø = 0.8 mm • diffracted beam path: 0,15° soller slit
Diffraction angle:	2θ = 20°
XSA-Mode:	symmetrical Ψ–Mode (reflection), ψ = 0° ... 70°: Δψ = 4°, ψ = 70° ... 80°: Δψ = 2°, ψ = 80° ... 89°: Δψ = 1°
Detector	Low energy solid state Ge detector (Canberra Model GL0110)
Counting time per spectrum:	2400 s
Diffraction lines:	110, 200, 211, 220, 310, 222, 321, 330/411, 420, 332
Calibration:	tungsten powder

Part-financed by the European Union

The two samples were measured, but due to unfavourable specimen geometry and too low X-ray energy, only radial stresses could be measured within a thin part of the sheet thickness. We needed a through-thickness measurement for our study, as described in our application, see the results below mapping only 50 mm of the 1 μm sheet.





How would you describe cooperation and assistance from industrial liaison officers and national contact points while preparing and carrying out the research at large scale facilities?

The assistance from the liaison officers and national contact points were excellent, now when we have problems with the result they try to help us. The application procedure was short and non-bureaucratic from our viewpoint. The contact point at the large scale facility was very helpful and professional, as well as the performing researchers. What was missing was the communication between us, to explain what we wanted, but that is a learning for a possible future use of a LRI.

Other personal remarks

It would have been good to have been more actively involved personally in the testing and discussion with the researchers, e-mail was not working in this case.
It is extremely valuable for companies and researchers in Europe to have these LRI with their excellent researchers at hand when needed.

Annexes

Annexes (list of annexes; meeting minutes, graphical illustrations, tables and other supplementary data)

Part-financed by
the European Union