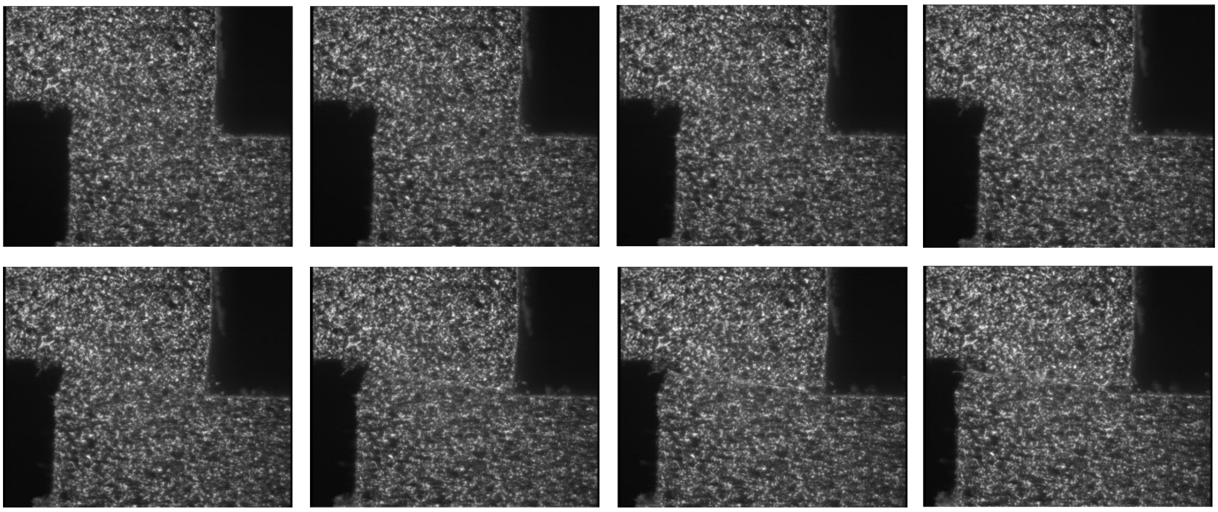
Application note

No. 14

SPECIALISED IMAGING

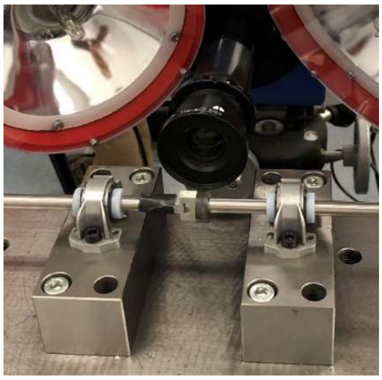
Ultra-high speed video camera captures image for 2D DiC measurements



Images Courtesy of Nordmetall GmbH

EXPERIMENT OVERVIEW

The purpose of the test was to measure the movement of an aluminium sample undergoing adiabatic shear along a 2mm shear region. The movement was to be measured using Digital Image Correlation software. The shear impulse was imparted onto the specimen using a Split Hopkinson Bar experimental set up.



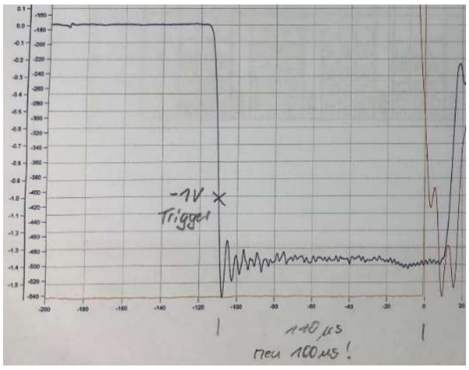
EXPERIMENTAL SET UP

Illumination

Two AD500 flash lamps were used to illuminate the sample evenly and prevent any shadows that might affect the DiC measurements.

Camera

The KIRANA camera was set to 5 million pictures/second with a 100nS shutter and used a 50mm Titanar F2.8 lens with 500mm of extension tube to bring the camera closer to the test piece and provide a field-of-view of approx. 5mm x 4mm.



Triggering:

A strain gauge bonded to the input bar provided the trigger from which all subsequent trigger timing was derived. This was connected to the KIRANA camera via an oscilloscope to check and measure the camera and illumination synchronisation. The strain gauge trigger was 110µS in advance of the impulse reaching the test sample. The flash lamp illumination required a rise time of 50µS and maintained peak brightness for 2mS. The KIRANA trigger output was set to provide a 50µS delay to the AD500 flash lamps using the camera control software.

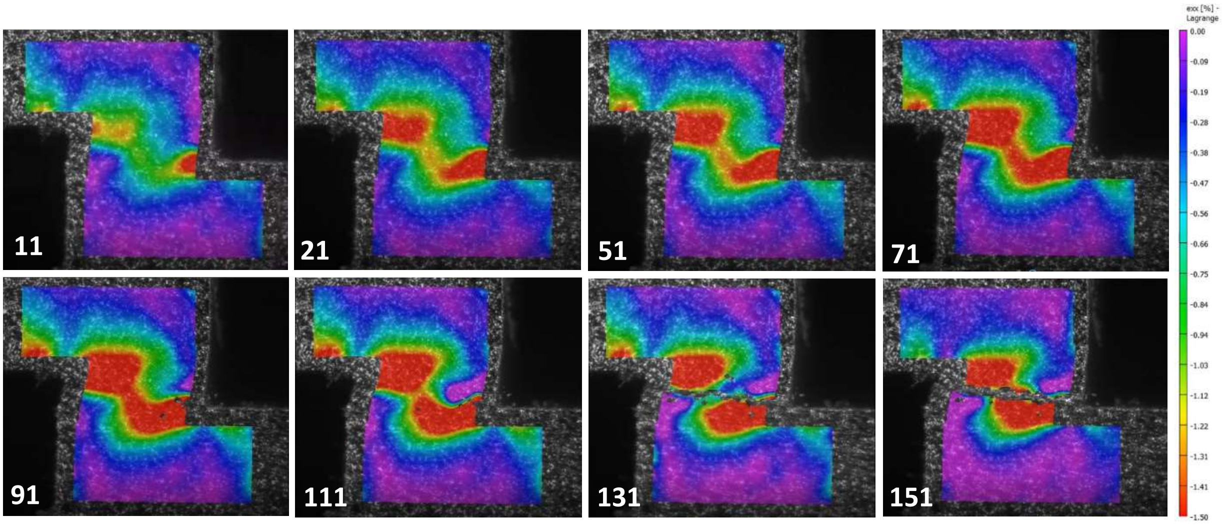
UK (Head Office / Factory)
6 Harvington Park, Pitstone Green Business Park, Pitstone. LU7 9GX England
+44 (0) 1442 827728

USA
Specialised Imaging Inc.
40935 County Center Dr. Suite D
Temecula, CA 92591, USA
+1 951-296-6406

GERMANY
Hauptstr. 10,
82275 Emmering
Germany
+49 8141 666 89 50

specialised-imaging.com info@specialised-imaging.com

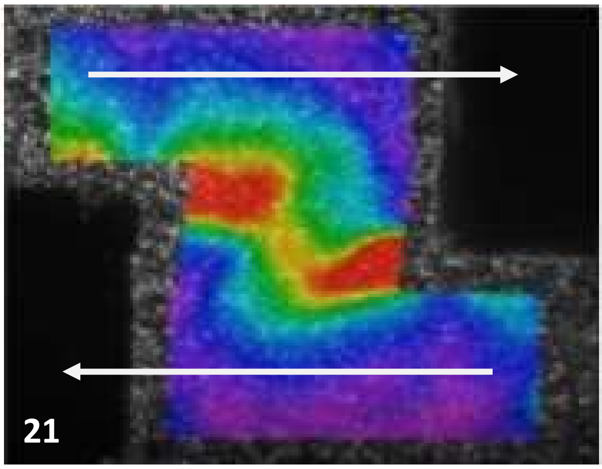
RESULTS



The imaging results were analysed using Correlated Solutions Vic-2D DIC software. The above analysis show exx lagrange strain (strain in the same direction of motion) for the same images shown previously.

Maximum strain is denoted by the regions of red, this corresponds to a strain percentage change of 1.5%. The areas of minimum strain are shown in purple, in these regions there is zero stain in the x-direction.

From the first image, it is clear a shear band of heightened strain occurs at approximately 45^{o} to normal. As the specimen begins to ‘slide’ relative to itself, pure shear is induced, starting from the outside edges and converging in the centre. This is shown right:



In an adiabatic shear test such as this, the strain localises along precise shear bands. This occurs due to high-strain rate loading giving rise to localised heat concentrations which do not have time to conduct in the bulk material. This high temperature ‘band’ deforms far more readily than the cooler bulk material. In a slower, more static test the strain field would be less localised, due to these isothermal conditions.

Images 131 and 151 exhibit specimen failure. As cracks occur on the surface the ‘speckle pattern’ used to gather DIC results is interrupted. This interruption does however provide the opportunity to track crack formation and propagation. As would be expected, the crack propagates from the outside edge of the specimen and moves horizontally through the centre of the shear region.

To improve this work some suggested further work includes:

- Viewing shear results instead of exx – This would allow the quantification of pure strain to take place and give a better view of the shear band that occurs.

- Increase the maximum strain limit – The large areas of ‘maximum’ strain can be refined if the maximum value is not capped. By increasing this cap the localisation of strain can be further understood.

UK (Head Office / Factory)
6 Harvington Park, Pitstone Green Business Park, Pitstone. LU7 9GX England
+44 (0) 1442 827728

USA
Specialised Imaging Inc.
40935 County Center Dr. Suite D
Temecula, CA 92591, USA
+1 951-296-6406

GERMANY
Hauptstr. 10,
82275 Emmering
Germany
+49 8141 666 89 50

specialised-imaging.com info@specialised-imaging.com