Measurements inside aluminium alloy sample after laser shock and shot peening

Stefano Coratella[1], Mike Fitzpatrick[1], Michael Gharghouri[2]

[1] Department of Design, Environment and Materials, The Open University, Milton Keynes, United Kingdom
[2] Canadian Neutron Beam Centre, Chalk River Laboratories, Chalk River, ON, Canada

The aim of the study was to fully understand the distribution of the residual stresses after two separate surface treatments: laser shock peening and shot peening on an aluminium alloy component. Shot peening is widely used in aerospace field a surface treatment to introduce high residual stresses inside a structural component with the aim of retarding the crack initiation process. Laser shock peening is a relatively new treatment that allows introducing higher compressive residual stresses than shot peening. Lately an important study demonstrated that an aluminium sample subjected to both laser shock and shot peening has a high fatigue life than a component subjected only to laser shock peening. Some preliminary measurement of surface residual stress distribution was made and they confirmed the presence of compressive residual stress. The scope of this study was to reveal the distribution of the residual stresses into the thickness of the sample. For this reason neutron diffraction technique was chosen.

As it is possible to see from figure 2, the distribution of the residual stresses was the one expected. In particular the image on the left shows the distribution from side to side of the sample crossing the thickness where both treatments were present. This brought to have a compressive residual stress at the start of both surfaces. In the middle a plateau is reached, the balancing tensile stresses are not bigger than 125 MPa in S1 direction. In the second graph the profile reaches a peak in tensile stresses and then a decay to almost 0 MPa as expected. Both S1 and S2 component are very similar. The S3 component is around 0 MPa in both graphs, confirming that the distribution of stresses is plane stress. At the notch position, so between 0 and 2 mm, some pseudo stresses are present even if some correction were made. In that position the sample was narrow and this made the measurement even more difficult. The same correction technique was used very close to the lateral surface of the sample with nice results as it is possible to see in the first graph.

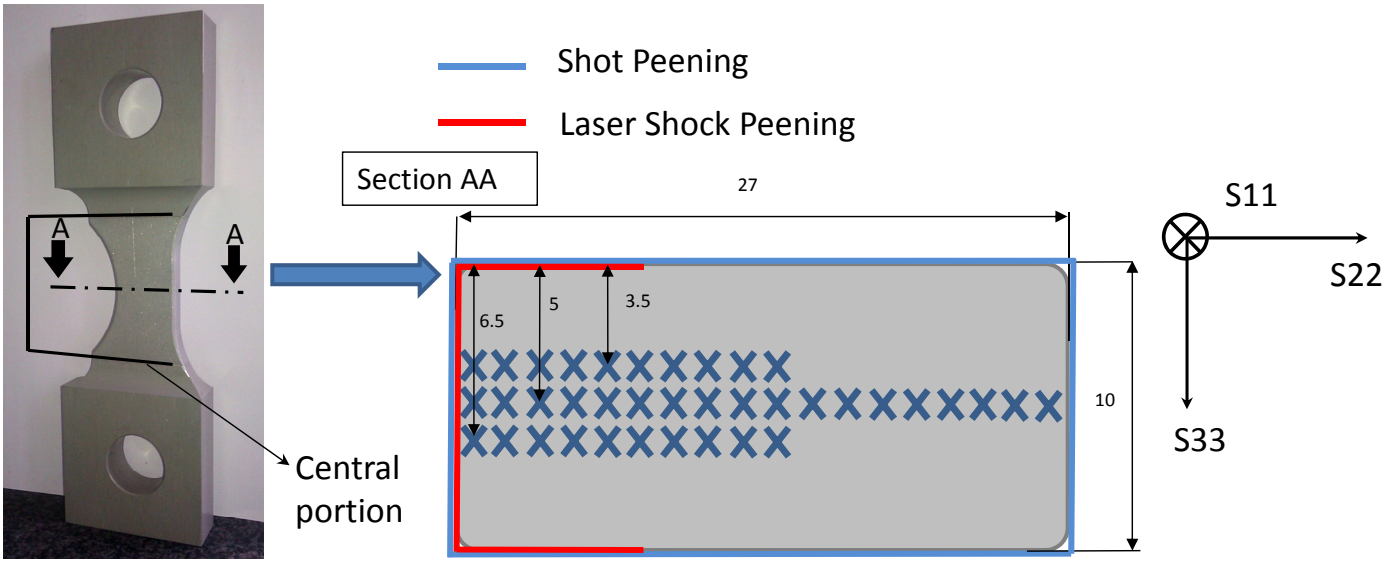
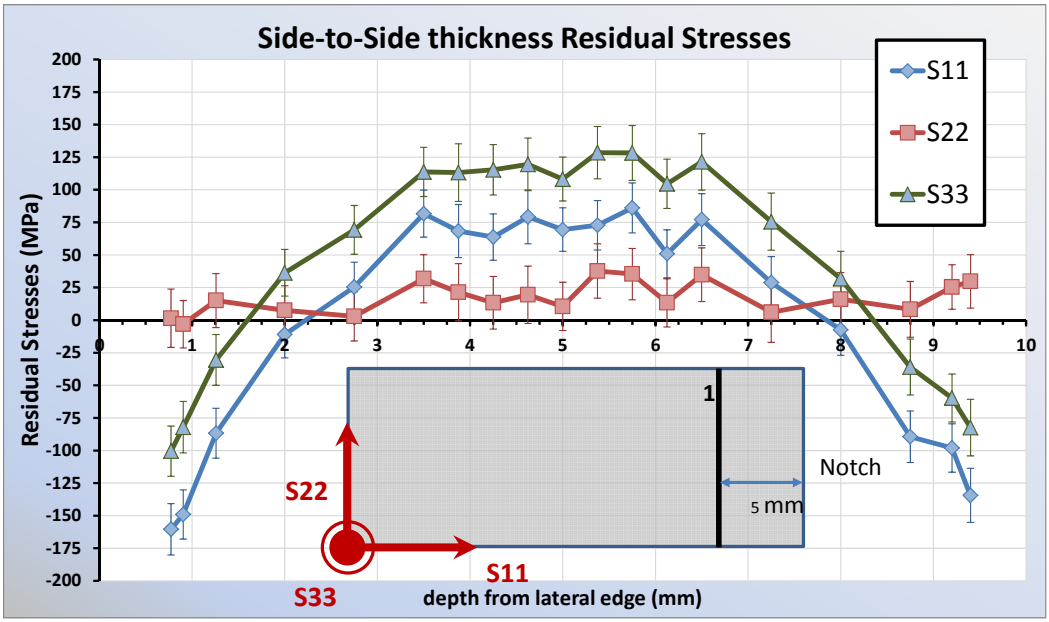


Figure 1 On the left is a picture of the entire sample and the area of measurement; on the right is a drawing of the area of measurement and position of laser shock and shot peening treatment.



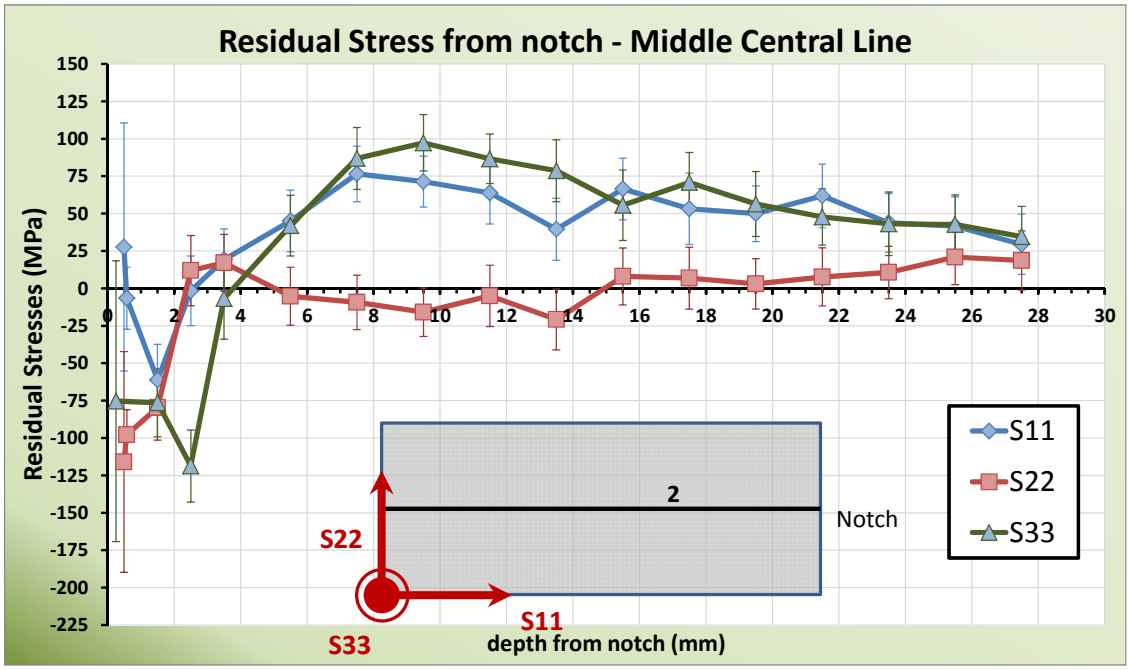


Figure 2 On the top is the distribution of the residual stresses taken through the thickness from side-to-side. On the bottom is the distribution of the residual stresses from the notch into the thickness.