Biaxial Deformation of 6061 Aluminum Alloy

Phil S. Tomlinson[1], Warren J. Poole[1], Chad W. Sinclair[1], Michael A. Gharghouri[1]

[1] Department of Materials Engineering, University of British Columbia, Vancouver, BC, Canada
[2] NRC Canadian Neutron Beam Centre, Chalk River Laboratories, Chalk River, ON, Canada

Biaxial testing of 6061 aluminum alloy was conducted using a combination of axial stress and internal pressure using the same experimental setup as Marin et al. [1], illustrated in Figure 1. The purpose of this work was to verify the proper functioning of a similar experimental setup developed at The University of British Columbia, as well as to provide a baseline material response against which to compare subsequent work on magnesium alloys. Hollow, cylindrical samples where subjected to internal pressure via hydraulic fluid, inducing both hoop and axial stresses within the sample wall; this was then complemented by axial loadings achieved with a load frame in order to vary the degree of biaxiality at the point of yield.

Samples were pressurized to 6.9MPa, 17.2MPa and 27.6MPa before axial loading was then applied. Samples were then deformed to a measured strain of 0.03 before subsequent unloading. The resultant biaxiality ratios from these tests were 0.26, 0.58 and 2 respectively.

A von Mises yield surface was constructed using the results of this testing and subsequent experiments conducted at UBC were then compared to this yield surface. As illustrated in Figure 2, agreement was shown to be generally good between the two experimental rigs, facilitating the direct comparison of results garnered at the two facilities.

Magnesium alloys are known to be highly anisotropic and prone to significant textural evolution during mechanical testing resulting from deformation twinning. Texture measurements were conducted on the tested aluminum samples in order to ascertain the sensitivity of this material to differing biaxiality ratios and provide a well characterized point of comparison with future works involving magnesium alloys.

The pole figures presented in Figures 3a and 3b, for uniaxial tension and biaxiality 2 respectively, indicate that the final texture of the samples is effectively the same, regardless of degree of biaxiality in the loads indicating altogether different deformation behaviour than that observed in magnesium alloys.

References

[1] T. Marin, P.R. Dawson, M.A. Gharghouri and R.B. Rogge, Acta Mater., Vol. 56, PP 4183-4199.

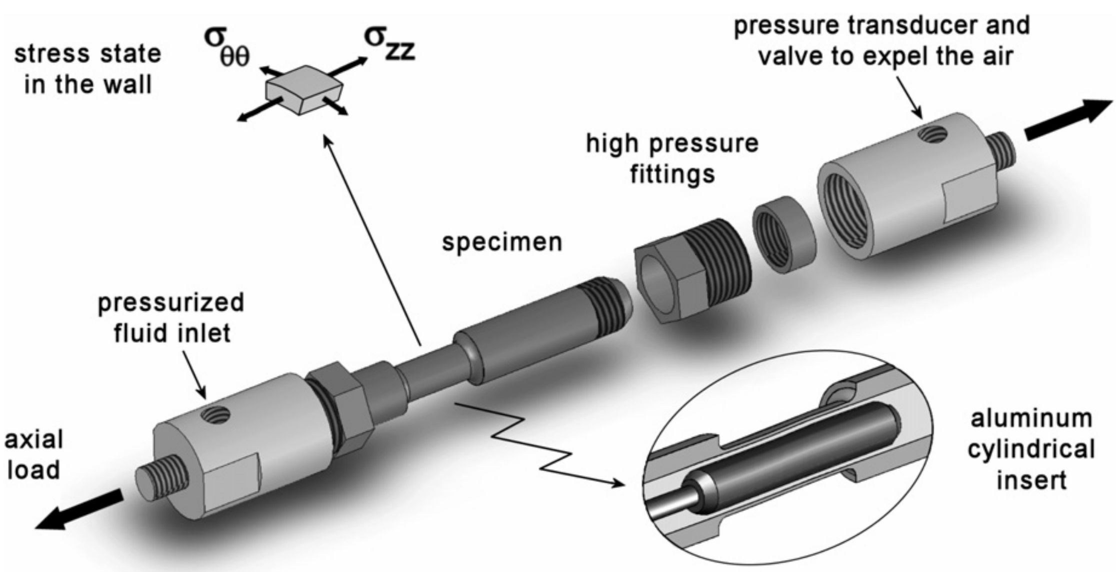

Fig. 1 Sample setup employed for testing. A combination of internal pressure and axial load permits various biaxiality levels at yield. [1]

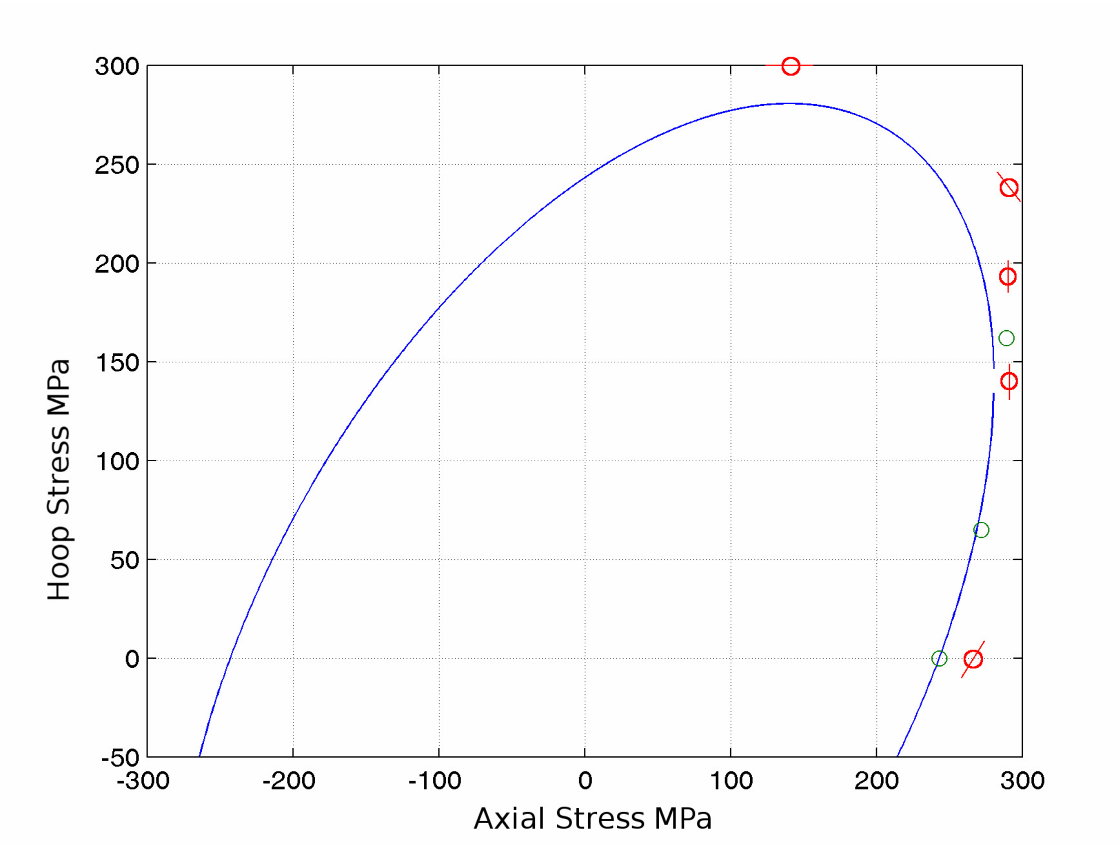

Fig. 2 Experiments conducted at CNBC (green) compare favourably with similar testing conducted at UBC (red).

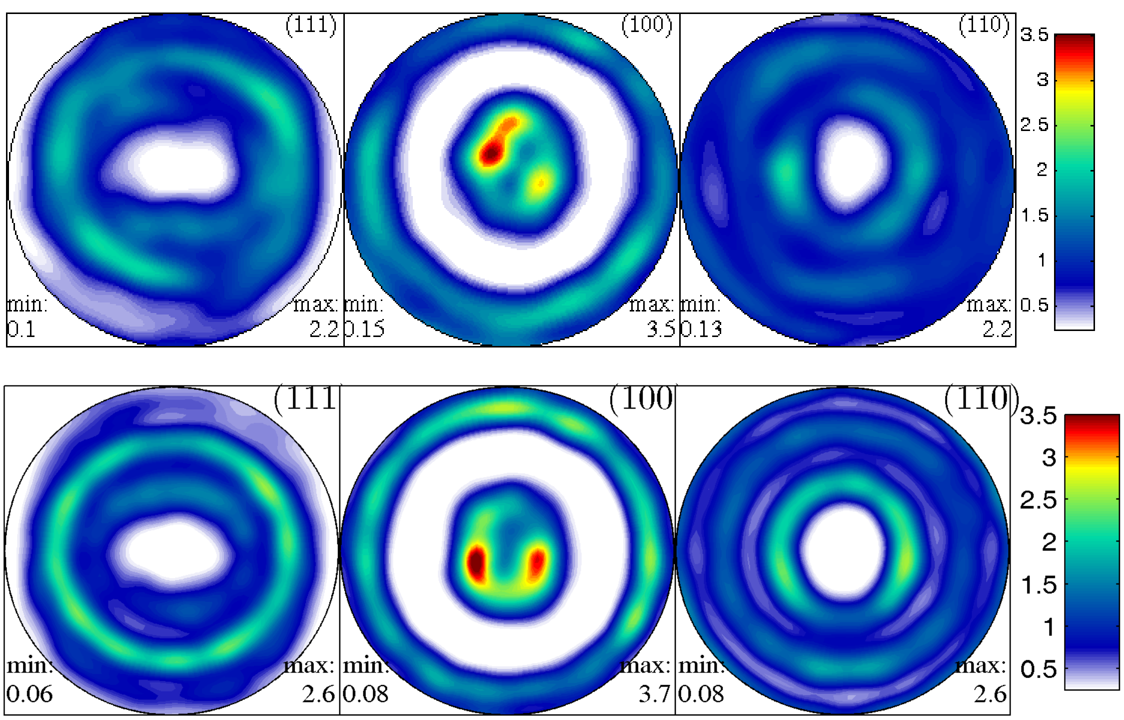

Fig. 3 Pole figures for a) Tension b) Biaxiality 2, the two most differing cases, indicate negligible differences.