Neutron Diffraction Measurements of Residual Stress in Roll-Formed Dual-Phase Steel Tubes

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Dual-Phase steel tubes fabricated by roll forming and seam welding are bent and hydroformed to produce structural members for automotive applications. However, there are significant residual stresses in the tubes in the as-received condition. The presence of residual stresses, in part, affects the springback (elastically driven shape change upon removal of forming loads) of the tube after bending and hydroforming. In practice, springback is accounted for by using the finite element method in manufacturing process modeling so as to achieve a near-net shape during fabrication. Residual stresses then are required as initial conditions in the finite element mesh of the tube in the process modelling effort. In the present work, residual stresses in 50.8-mm diameter, 2-mm thick DP980 tube were measured using neutron diffraction; DP980 is a dual-phase steel with approximately 33% ferrite with the rest being martensite. Diffraction peaks from {211} planes were obtained.

Reference diffraction peaks from the {211} planes in matchstick samples cut from sheet, as well as the tube were obtained. Peaks from {211} planes in the sheet and tube were obtained as a function of tube thickness, and circumferential location. Axial and circumferential residual stresses along the circumference and at different tube wall thicknesses are shown below. Residual stresses in the radial direction are approximately zero.

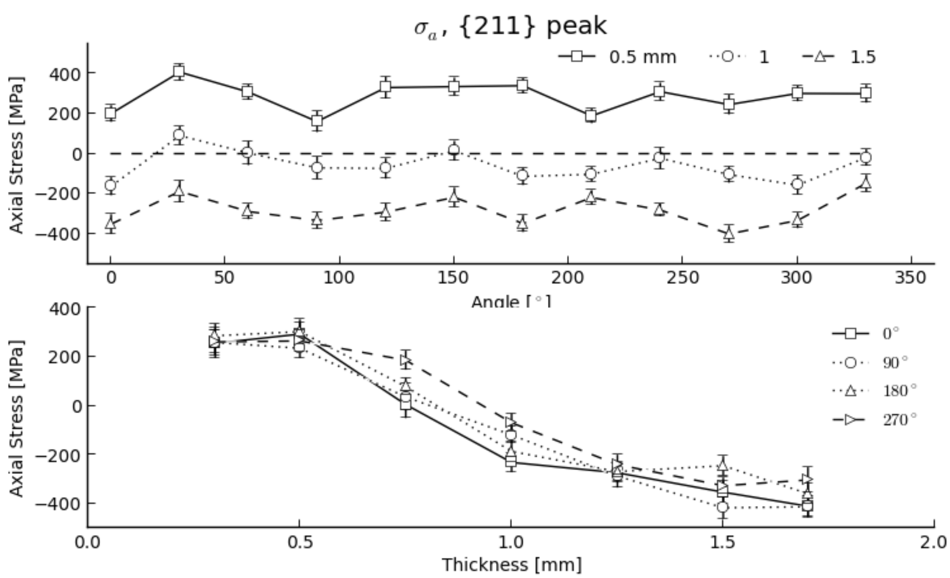

Figure 1 Residual stress in axial direction. Top: as a function of circumferential angle for three depths. Bottom: as a function of thickness for four circumferential locations.

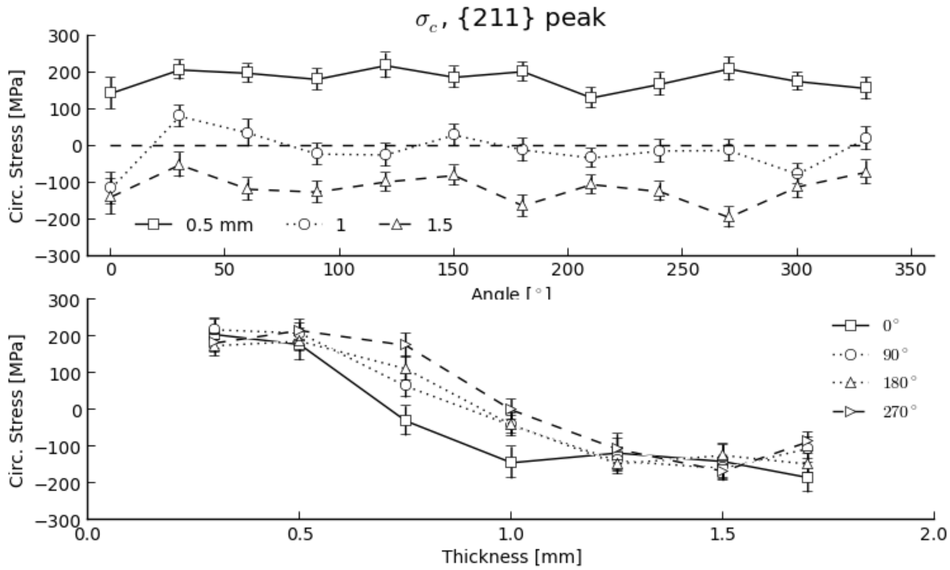

Figure 2 Residual stress in circumferential direction. Top: as a function of circumferential angle for three depths. Bottom: as a function of thickness for four circumferential locations.