Residual stress analysis of aluminium welds with high energy synchrotron radiation at the HARWI II beamline

Torben Fischer, René V. Martins[1], Andreas Schreyer
GKSS Research Centre, Max-Planck-Str. 1, 21502 Geesthacht, Germany
[1] Joint Research Centre, Westerduinweg 3, 1755 LE Petten, The Netherlands

In civil aircraft production advanced welding techniques are used to reduce weight and production costs. The way towards a rivet-free aircraft is supported by laser beam welding (LBW) and the development of new weldable, high-strength aluminium alloys. In this study residual stresses in laser beam welded butt joints of aerospace grade aluminium alloy AA6056-T6 were characterized using high energy synchrotron radiation. Because of its improved corrosion resistance und good weldability alloy AA6056-T6 (AlMgSi) will substitute standard AA2024 alloy (AlCu) for the manufacturing of forthcoming aircraft fuselage skins. Al-sheets with a thickness of 3.2 mm and 6 mm were welded by a CO_2 laser beam. The metallographic analysis of the samples shows grains with a diameter up to 0.3 mm. This large grain size makes the measurements with high spatial resolution more difficult due to the poor grain statistics. The strain scanning was performed at the new high energy synchrotron beamline HARWI II of the GKSS research centre at HASYLAB in Hamburg, Germany. The use of high energetic photons from 80 keV – 120 keV enables diffraction experiments in a transmission geometry, which provides the information about the macroscopic stresses. A large sample-detector-distance ensures a high angular resolution for the peak position determination. The distance between the measuring points was 0.2 mm in the welding area and up to 2 mm in the base material. This yielded a very detailed profile of the residual stress for the longitudinal as well as the transversal component. Additionally, the influences of the gauge volume size and grain statistics on the strain measurements were systematically investigated. The results show that, with the given beam parameters, there exists an optimum gauge volume size for the peak position determination. For the t-joint configuration two dimensional stress maps were calculated from the data. For the near future an in-situ FSW experiment is planed to investigate the metallophysical processes during the welding.