SMALL CREEP DEFORMATIONS AND RESIDUAL STRESS RELAXATION IN WELDED AND SHOT PEENED ALMGSICU-ALUMINUM ALLOYS

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Precipitation hardened aluminum alloys are found in various applications of components for the aircraft, automotive and railway industry. Effective joining techniques are tungsten inert gas- and laser beam welding. These joining techniques result in microstructural changes and hardness losses in the different welding zones as well as in the generation of complex residual stress states depending on the initial heat treatment state of these alloys. These inferior properties of the welding zones are often compensated by shot peening processes. Service loads near the endurance limit reduce the peening induced residual stresses not completely. However there is some lack of information about residual stress relaxation after service loads at higher temperatures as the temperature for starting creep deformation is around 100°C. This paper reports results of residual stress stability after mechanical relaxation tests and thermal relaxation from a laser beam welded and shot peened wrought Aluminum alloy 6056. After shot peening typical distributions of residual stresses and strain hardening are observed for the base material whereas the weld material show some reduced residual stress levels. The relaxation tests for temperatures 100°C<T<150°C prove the existence of high threshold stresses. The level of these threshold stresses can be estimated to be in the range of Orowan stresses of the metastable precipitates. This is additionally proved by experimental data analysis. With the knowledge of back stresses the experimental results of relaxation tests could be well fitted with the Feltham equation. After the stress relaxation tests the shot peening induced residual stresses decrease to a large extend in the welding zones and remain almost stable in the base material. Pure thermal relaxation reduces residual stresses for temperatures >100°C and similar differences between welding zones and base material occur. Calculations of residual stress relaxation based on the stress relaxation tests underestimate the relaxation behavior due to the different nature of load stresses and residual stresses. This has to be taken into account during the service of surface treated components.