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FATIGUE PROPERTIES OF AW 6082 ALUMINIUM ALLOY AFTER SHOT PEENING AND ANODIZING

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1. Introduction

Even when it seems that anodized coatings are solving the major corrosion issue of aluminium alloys, they have negative effects on other, mainly mechanical properties. The amorphous coating is not completely uniform and contains many micro-cracks and micro-pores. Cracking also occurs during loading of the component due to extremely different moduli of elasticity of the coating and the substrate. These cracks serve as a strong stress concentration points (notches) in the process of cyclic (fatigue) loading, thus accelerate the process of fatigue crack initiation [1-3].

The shot peening as a surface treatment has proven that it is possible to significantly improve the fatigue resistance of various structural materials by introduction of compressive residual stresses and grain refinement of the surface layer. This application includes all commonly used structural materials as steels [4], aluminium alloys [5], nickel and titanium alloys [6] and even magnesium alloys [6]. Using the shot peening as a pre-treatment to anodize coating provides a chance to restore the fatigue properties of an anodized component.

2. Experimental material and surface treatment

The wrought AW 6082-T651 aluminium alloy was used as experimental material, which is widely used in automotive and aeronautical applications. For more information about used experimental material reader can referr to [7].

Surface strengthening was performed by the air blast shot peening with Almen intensity 6N and coverage of 100 %. To avoid the surface contamination by steel residues from ordinary cast steel peening media, fine glass beads with diameter of 0.4 mm and the impact angle 90° with respect to the specimen's axis were used. The surface topography after shot peening (Fig. 1) well documents the negative side effect of shot peening, which is the increase of the surface roughness.

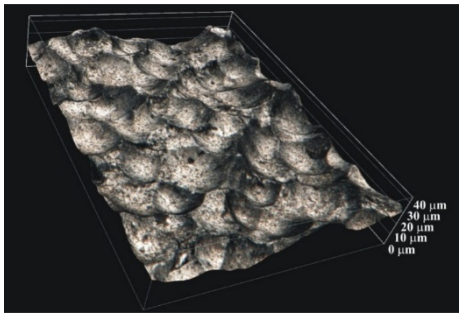

Fig. 1. Topography of surface after shot peening.

After the surface strengthening by shot peening, the sulfuric acid anodizing process at a constant current density of 40 $mA \cdot cm^{-2}$ in a bath containing 250 $g \cdot dm^{-3}$ H_2SO_4 at 20 ± 0.5 °C for 20 min, was carried out. Sealing was done in deionised water at 97 °C for a period of 4 min. The thickness of coating layer was measured by optical microscopy and was later confirmed by the SEM studies, as well. The average thickness of coating layer reached approximately 30 µm (Fig. 2).

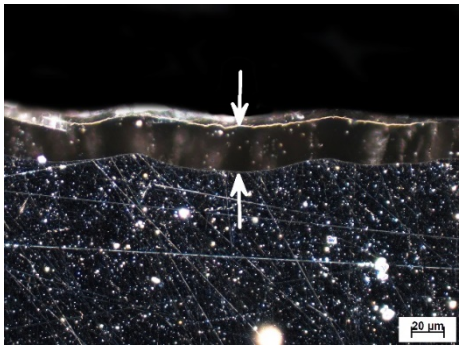

Fig. 2. Thickness of the anodized coating.

3. Results and discussion

According to the fatigue test results (Fig. 3), the shot peening significantly improved the fatigue strength of the AW 6082 aluminium alloy and the improvement is more or less constant over the whole measured interval of loading cycles ($N \approx 10^5 \div 10^{10}$). As expected, creation of the brittle anodized coating on the shot peened surface decreased the fatigue strength of the specimens. However, the total fatigue strength of the shot peened specimens with anodized coating is still higher than of the specimens without any surface treatment. An interesting fact is that the fatigue life curve of the shot peened surface and anodized tends to converge at approximately $N \approx 4 \times 10^8$ cycles with the fatigue life curve of shot peened specimens. Beyond this point, the fatigue strengths of specimens with shot peened and shot peened + anodized surfaces are very similar.

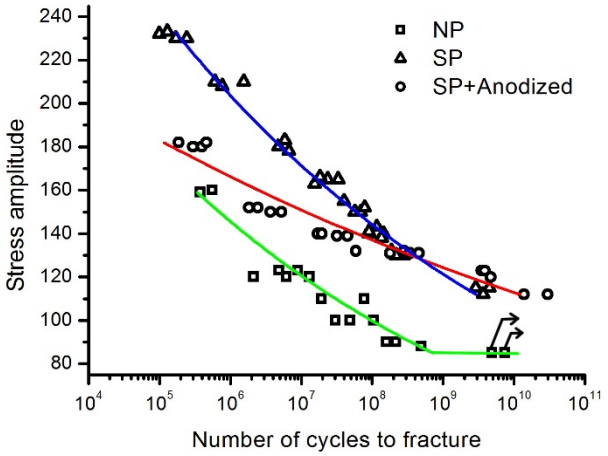

Fig. 3. S – N curves of not peened, shot peened and shot peened + anodized specimens.

When the high loading stress amplitude is applied (corresponding to the lower number of loading cycles to fracture), the brittle anodized layer starts to crack and the cracks serve as sharp notches and accelerate the fatigue crack initiation in the substrate. However, when the crack from the anodized surface layer hits the strengthened shot peened layer of the substrate, the compressive residual stresses cause necessity of re-initialization of the fatigue crack and slow down the fatigue crack growth in early stages. At low stress amplitudes, corresponding with the region above $N = 5 \times 10^8$ cycles, the anodized layer is able to stay compact longer and together with the strengthened surface layer by shot peening further improves the fatigue life.

4. Conclusions

The shot peening with glass beads was used as a pre-treatment to anodizing on AW6082 aluminium alloy with aim to reduce the negative effect of anodizing on fatigue properties of the substrate. According to results of experimental works and their discussion, the following can be concluded:

- The shot peening performed with Almen intensity 6N and coverage of 100 %, was able to improve the fatigue properties of the AW 6082 aluminium alloy in the whole measured region.
- Despite the negative effect of anodizing on fatigue life, application of the shot peening as the pre-treatment caused that even with anodized surface layer, the fatigue strength was higher than that of the not treated material in the whole investigated region of fatigue loading.

Acknowledgements

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