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ASSESSMENT OF DAMAGE DEVELOPMENT DUE TO FATIGUE OF 2017 ALUMINUM ALLOY ON THE BASIS OF CONDUCTIVITY MEASUREMENTS

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1. Introduction

The study concerns experimental capability of conductivity measurements application for damage development analysis of the 2017 aluminum alloy subjected to various fatigue loading conditions. It is well known that a process of degradation due to fatigue is developing locally around structural notches, where stress concentration may lead to crack initiation before the fracture of a specimen will occur. Such a structural degradation enforces a local changes of conductivity, which allow to indicate a damage initiation place and monitoring of the dominant crack growth.

2. Material and research methodology

The tests were performed on specimens of the 2017 aluminum alloy cut from sheets of thickness equal to 1, 2, and 3 mm. Figure 1 shows the geometry of specimen and places of conductivity measurements during fatigue tests.

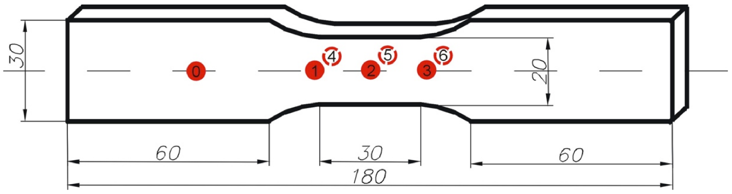

Fig. 1. Specimen geometry and conductivity measurement points.

The measurement points were located on both sides of specimen gauge length (points 1, 3, 4, 6) as well as on its gripping part as a reference point (0). Additionally, another two points were selected in the points (2, 5) where the highest stress concentration was expected.

The geometry and size of the specimen enable the conductivity measurements to be done using the manual Ferster device (Fig. 2a). During fatigue tests the specimens were

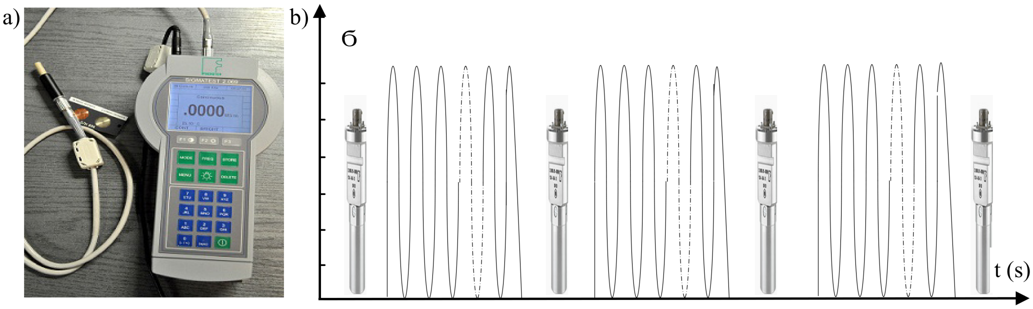

Fig. 2. Sigmatest 2.069 equipment (a), and a scheme of the loading programme (b).

subjected to cyclic tensile stress using the MTS 810 servo-hydraulic testing machine. Each test was stopped after selected number of cycles, and subsequently the conductivity measurements were carried out on the unloaded specimen, Fig. 2b.

Deformation changes during subsequent cycles of the fatigue test were monitored using the MTS axial extensometer. Tests were carried out up to a dynamic increase of specimen deformation indicating an initiation of the dominant crack and its fast growth.

3. Results

The conductivity variations versus number of cycles are presented in Fig. 3 for all points selected on the specimens for measurements. For three specimens of different thickness one can see local reduction of the conductivity on both specimen sides.

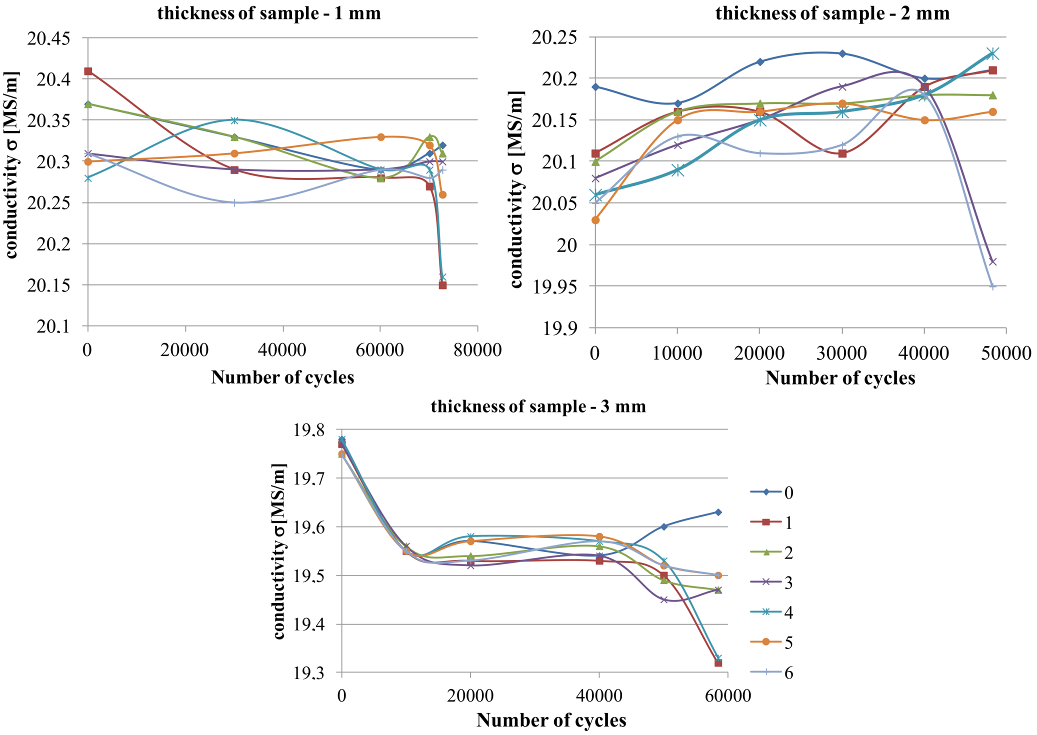

Fig. 3. Changes of conductivity of aluminum alloy for three specimens of different thickness.

A decrease of the conductivity in the final stage of fatigue test is clearly visible, Fig 3. It was located at that point, where the cumulative fatigue damage was most advanced. It has been found for all tested specimens that the measuring point corresponding the conductivity decrease in subsequent cycles represents the point where specimen fracture was obtained. This enables to conclude that the conductivity measurements may be promising technique for fatigue damage analysis, especially for an identification of areas where the dominant crack propagation takes place.

References

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