Analysis of Laser Shock Peening on Aluminium Alloy 7075 with Different Types of Sacrificial Coatings

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Abstract

This research project was aimed at the advancement of the Laser Shock Peening (LSP) process, by using 11 different ablative/sacrificial media (mainly adhesive tapes) on 7075-T651 aluminium alloy for the aeronautical industry. The LSP process is a surface enhancement treatment that induces compressive residual stresses into the material. The research carried out in this document focuses on studying the effect that the different ablative tapes have on the surface integrity and the residual stress profile of the treated samples by using four different laser power intensities. The surface integrity of the treated samples was investigated using optical microscopy, scanning electron microscopy (SEM) and by using two types of surface roughness testing. While the compressive residual stresses were mainly evaluated using Incremental Hole Drilling (IHD) and then by Laboratory X-Ray Diffraction (L-XRD) for comparative purposes for near surface residual stresses. The results obtained were favourable, the sacrificial tapes each provided unique results, but the samples coated using the tape backed with the vinyl material showed the highest compatibly with the LSP process. It was found that, not only does the ablative layer influence the LSP results, but the thickness of the ablative material itself changes the outcome of LSP. An additional study was conducted by changing the laser coverage density using the vinyl backed tape while keeping the other laser parameters constant. The results from both studies showed a clear trend in the surface characteristics of the peened sample and the induced residual stress depth profiles, the results also compared well to the finding outlined in literature. Some experiments were restricted due to the availability of apparatus, equipment, labour and cost. Therefore, additional samples and tests are recommended for any future projects. The work conducted from this study will contribute to the LSP database for various alloys that can be used for industrial engineering processes and for the development of Finite Element tools for LSP.