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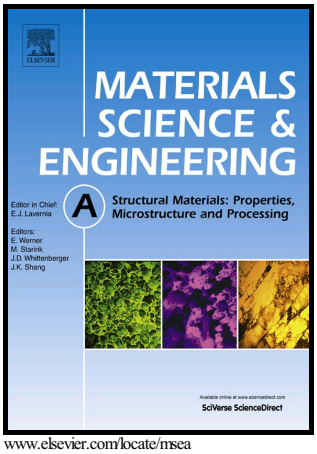

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The in-depth residual strain heterogeneities due to an indentation and a laser shock peening for Ti-6Al-4V titanium alloy

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Abstract

Heterogeneity of the through-thickness residual strain due to the laser shock peening (LSP) process in comparison with that due to the indentation was studied in Ti-6Al-4V alloy samples. The latter is almost a quasi-static process while the former features extremely high strain-rate deformation. The synchrotron based high-energy X-ray diffraction was employed to investigate the through-thickness residual strain distribution. The studied two samples feature almost equal both indentation/peening affected depths (~2 mm) and the maximum magnitude of compressive residual strains (~4000 με) parallel to the surface. The pit depth for the indentation is ~9 times higher than that for the LSP. The position featuring the maximum magnitude of compressive residual strain is in the sub-surface for the indentation while it is in the surface for the LSP. Results of the elastic-visco-plastic finite element simulation for the indentation indicate that the position featuring the maximum plastic deformation corresponds to the maximum magnitude of compressive residual strain. Full width at half maximum (FWHM) of the X-ray diffraction profile can indicate the level of the plastic deformation. It is found that positions with the maximum FWHM indeed correspond to the maximum magnitude of compressive residual strain for both tests.

Key words

Laser shock peening; indentation; Ti-6Al-4V; residual strains; elastic-visco-plastic finite element model.

1. Introduction

Residual strains are typically caused by heterogeneously evolved plastic deformation or thermal mismatch during the manufacturing, welding or joining of

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