Validation of the results of numerical simulation of laser shock peening using computer tomograph and microhardness measurements

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In order to evaluate the residual stress of the process of laser shock peening (LSP), a combined method based on simulations, computer tomography (CT) and microhardness measurement was applied. The LSP process differs from other types of surface hardening technologies in more intensive conversion of tensile stresses into compressive stresses, which reduces the risk of microcracks and thus increases the fatigue strength of the entire part. The plasma formed at the moment of contact of the laser beam with the metal surface leads to the formation of a micro explosion, deforming the surface, with a local increase in the density of dislocations and, as a consequence, with the hardening of the material or increase in residual stresses. The obtained computer model for steel 1.3355 and aluminum alloy 7075 the potential level of values and sign of residual stresses was evaluated. Using CT technique, areas of increased density were identified, which may indicate an increase in the accumulation of dislocations and a high stress level. To further confirm that the areas of increased density are hardened areas, microhardness measurements were performed on the surface and in depth of the specimens. The volumetric data map with the assumed areas of residual stresses obtained in this way was superimposed on the result of computer simulation and the deviations in the level of values and sign of residual stresses were evaluated. To reduce the calculation errors, corrected calculations were performed by changing the values of the material fracture model coefficients.