Experimental and numerical investigation of laser shock peening

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In this work, an experimental and numerical study of the process of laser shock pinning [1] was carried out. This is one of the promising methods for increasing the fatigue life of metal structural elements. The essence of the method is the impact of a laser pulse on the surface of the material. At a high pulse energy, a plasma is formed, with an increase in the pressure of which a shock wave arises, propagating deep into the material. As a result, a layer (up to 1–2 mm) with residual compressive stresses is formed in the material, which prevents the initiation and propagation of fatigue cracks [2]. Also, the material increases hardness, wear resistance, resistance to corrosion. A numerical simulation of the process of laser shock pinning was carried out. The algorithm consists of two steps. Firstly, elasto-plastic stress waves propagation induced by the pulse loading is modelled using the explicit time integration. Secondly, a static equilibrium problem is solved with implicit time integration. As a result, residual stress distribution is defined. The model was verified by experimental in-depth residual stress profiles obtained for Ti64 by Hole-Drilling Method under different laser intensities up to 40 GW/cm^2. The research is supported by grant of the Russian Science Foundation (project No. 22-79-10168).

[1] Ding K and Ye L 2006 *Laser shock peening: performance and process simulation* (Cambridge: Woodhead Publ. Ltd)

[2] Yang J M, Her Y C, Han N and Clauer A 2001 *Materials Sci. Engng. A.* **298** 296 – 299