Study of Migration of Elements on the Metal Surfaces after Laser Shock Peening

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Laser shock peening is an enough well-known technology of surface material treating. The treated surface is previously covered by non-transparent layer (paint) and transparent layer (water). The energy of the laser pulse is absorbed by the non-transparent layer, which leads to its heating, evaporation and the formation of a high-temperature plasma bounded on one side by the surface of the material, and on the other, by a transparent layer that restrains the spread of the plasma temperature. Due to the limited volume, the gas pressure rises sharply to high values and passes into the metal, creating a shock wave in it, which leads to the appearance of compressive stresses in the material. If these stresses exceed the elastic Hugoniot limit, then the material plastically deformed. Residual stress states strengthen the surface layer of radiated metals.

The non-transparent layer serves as protection against direct contact of the sample surface with laser-induced plasma, and also helps to match the surface properties for interaction with laser radiation, regardless of the actual properties of the sample. Direct interaction of the sample surface with plasma leads in most cases to the formation of a metal melt on the surface. That is why when making peening it is important to control the absorption of paint on the surface and, in the same time, to study fractions and chemical elements migration in the laser action zone.

The paper describes the study of chemical composition of the steel and aluminum alloys before and after laser shock peening. The samples were treated with Nd:YAG-laser (λ=1.06 μm), pulse repitition rate 25 Hz, speed 900 m/s, power 24 W. Three types of paints were used and different number of peening passes.

The estimation of chemical composition of surface was studied by LIBS-method (laser induced breakdown spectroscopy). The diffusion of paints and migration of elements of the substrate was observed layer-by-layer way with the aid of scanning sampling – three times from the same sampling path.

It was found out that the very surface layer is always depleted with Mn. This trend ia common for almost all the studied samples metals and paints. At the same time Ti shows local maximum for some paints. Some other trends and their comparative analysis are presented in the work.