THE USE COMBINED TECHNOLOGIES TO STRENGTHEN SURFACES

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Introduction. The laser surface hardening (*LSH*) of metals was discovered in 1965. It has won strong positions in technology of metals [1]. Nowadays in the whole world hundreds of patents have been awarded to branch inventions including those dealing with combination of *LSH* with *SHS* (self-propagating high-temperature synthesis). One of them is dedicated to combining of *LSH* (Laser Surface Hardening) with *SHS* (self-propagating high-temperature synthesis) [2-4]. Formerly *SHS* was combined with other technologies of surface hardening of components [5-9].

Theoretical and experimental research. The impotent problem within the *LSH* is the decreasing of the losses of beam energy because of its reflection by the surface of metal under machining. In the given investigation, as well as in the invention [1,2], the mixture of powders *Ti* (65%), carbon in black state (18%) and *Fe* (14% by mass) were used in the role of light-absorbing paint. The mixture was damped by solution of 2 % latex in gasoline, and then it was put on the surface of stalls of mark 10 and 20 and was dried in an open air, forming the layer 80, 200 or 500 mkm thick. Thermochemical calculations showed that in such a mixture practically all *Ti* interacts, thanks to non-oxygen combustion, with carbon, forming the carbide *TiC*. The seer plus of carbon and very small account of *Ti* alloy the iron forming liquid steel of condition, which under fast cooling turns into troostite in layers of 80 mkm thick.

The adiabatic temperature of non-oxygen combustion of equiatomic mixture *Ti-C* equals to 3200 *K*. The real temperature of combustion of selected mixture 68% (% in mass particles) is more than 1850 *K* that provides the formation of hard-liquid dross (*TiC*-melding) with the large interval liquids solid us. The formation of dross instead of one-phase alloy influences positively on the quality of surface of hardened layer after its full growing hard and cooling as well as on supporting of this layer even on inclined planes.

It is important to note that in the mentioned non oxygen combustion none of nonmetallic phase and its including is formed. Welding of hardened layer with basic metal is obtained automatically „metallurgic ally", excluding the necessity of soldering or other methods of connecting one alloy (e.g. instrumental) with other (e.g. with the basis of cutting tool).

In typical microstructure of metal in cross-cut of harded layer got under density og power 17 $W \cdot m^{-2}$, diameter of „spot" – 0,4 mm, the speed of scanning 12 min/s and expense of argon (for the defense of *Ti* from air oxidation) – 0,5 l/s is shown. The thickness of alloy is ~500 mkm. This layer consists of ~50% particles *TiC* and ~50%(by volume) of metal link-instrumental carbon steel of type "Y8".

The investigations made have proved that the microhardness of carbides TiC is higher than the hardness of steel almost 10 times. Thus, in the given work we managed to organize the *SHS* process in comparatively thin layer thanks to using of

LSH technology simultaneously for solving of two tasks: for heating, flashing and carbonating of an iron; for flashing *Ti* particles and its „combustion" in carbon with forming of carbides *TiC*.

The substitution of a part of iron powder by the powder of carbon ferrochrome (e.g. 12%*Fe*+2%*FeCr* instead of 14%Fe in the formulae of SHS mixture) allows to get layers of carbidosteel with the link not in the shape of steel "У8" but from alloyed steel "X12" which after fast cooling of these layers thanks to accelerated drain of heat to cold metal of the basis gets austenite-martensite-carbide structure. In the process of work of the instrument such metal link additionally grows hard thanks to pre-transforming of austenite into martensite and getting older of the later one. The hard of such a carbidosteel reaches *HV*1400 (14000MPa).

The substitution of a part of iron in the *SHS*-mixture by ferrochrome increases greatly corrosion resistance of carbidosteel and decreases its oxidizing wear in the process of its exploitation. The substitution of carbon in *SHS*-mixtures by the powder is also long-range. The same effect is obtained also with the substitution in another field of hot machining of metals namely the using of *SHS*-reactions for inmoulding process (modification within of the form) in casting manufacturing.

The substitution of carbon in *SHS*-mixtures by the powder of boron is also perspective. In such a case it is possible to reach the liquidus-solidus interval to 1500 *K*, that in other technologies it is practically impossible to meet. Thus, while the above mentioned method on the one hand high refractory diborides TiB_2 and CrB_2 (with high hardness) are formed and, on the other hand, very easily melted complex eutectics are formed.

Conclusions.

1. Combination of *LSH* and *SHS* in one operation allows to solve the whole complex of technical problems connected with producing of materials with high hardness like carbidosteels and hard alloys on metal surface.

2. Evolution of inner chemical heat in *SHS*-mixtures allows to decrease the power of laser radiation. 3. New complex technological process allows to build up wearied surfaces of parts of machines and devices to the high of 0,5 mm.

References:

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