HYBRID LASER-PLASMA COATING PROCESS

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Hybrid laser-plasma (HLP) process for coating deposition is developed by Paton Welding Institute. Characteristics of HLP process are as follows:

- formation of laser-arc discharge with increased stability;
- increasing of electron temperature in comparison with gas atoms and ions ones;
- wide range of steady-state conditions in consumption and composition of the plasma gas;
- possibility of the process controlling through varying the arc burning conditions;
- deposition of coatings in open atmosphere.

Two benches for hybrid laser-plasma deposition of coatings were developed and manufactured. The first bench is a combination of CO_2-laser and an up to 2 kW microplasmatron with the optical discharge generated by intersecting the laminar plasma jet by the laser beam at an angle of 90^o. The second bench consists of an up to 5 kW integrated laser-arc plasmatron (ILAP) with a coaxial feed of the CO_2-laser beam to the region of the arc discharge of the plasmatron. Differences of these systems are: different level of laser energy absorption by plasma jet and a possibility of direct laser beam action on sample surface.

The physical-mathematical model of the plasma jet generated by such a plasmatron was developed to design the integrated laser-plasma plasmatron and elaborate the hybrid laser-plasma spraying technology.

Experiments with diamond and DLC-coatings deposition by HLP process were carried out. Argon was used as a plasma gas and H_2/CH_4 mixture (95:5) or CH_4 were used as a reactant gas.

The diamond coatings were sprayed onto the surface of polished Mo and Si samples heated to 500-950 ^oC. Experiments on deposition of coatings from diamond-like carbon (DLC) were carried out with the substrate heated to 250-500 ^oC. Samples of carbon steel (St.45) and titanium alloy VT-6 were used as the substrate materials.

Structure, morphology and properties of the coatings were examined by scanning electron microscopy, Raman spectroscopy and microindentation method.

The experiments allowed proving the feasibility of formation of the diamond coatings by this method. A diamond layer with a globular or crystalline structure (depending upon the substrate temperature) is formed on the surface after 15 minutes of the treatment.

Thickness of the DLC coatings on the steel surface was 0.5-3.0 μ at a growth rate of 3-25 μ/h (depending upon the process conditions), and that on the titanium alloy surface was 13-17 μ/h. Hardness of the coatings measured by the

microindentation method on the steel surface was 8-35 GPa, and that on the titanium alloy surface was 15-30 GPa.

The results obtained are indicative of the possibility of realisation of the active gas-phase coating processes under conditions of the atmospheric-pressure combined laser-arc discharge, as well as application of the hybrid laser-plasma technology as an alternative to vacuum CVD technologies.