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UNIVERSAL PLASMA DEVICE FOR ION-PLASMA SURFACE STRENGTHENING TREATMENT

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This work is devoted to the development of equipment for a combined ion-plasma metal surface strengthening technology. An optimal combination of ion-plasma strengthening technologies should include a technology of modification of the mechanical properties of a metal surface by nitrogen ion implantation (nitriding) and a nanostructured coating deposition technology. The strengthening treatment object was a shaft. An ion-beam technology of high-intensity low-energy nitrogen ion implantation was used for nitriding. The implantation was implemented using an anode-layer ion source (accelerator). For nanostructured coating deposition, the authors chose an ion-plasma technology that uses an unbalanced magnetron sputtering system with a high-current pulsed magnetron discharge (HCPMD). This choice was due to the fact that both an anode-layer accelerator and a magnetron sputtering system use single-type discharges with closed electron drift, which facilitates their vacuum condition compatibility. An integrated system that includes an anode-layer accelerator and a magnetron sputtering system, i.e., independent plasma devices, was tested. That configuration was not found to be optimal because of its bulkiness. It was studied whether it was possible to make a magnetron sputtering system perform functions of coating deposition and collimated gas-metal plasma flow generation. If so, an unbalanced HCPMD magnetron sputtering system would become a universal plasma device for combined strengthening treatment. Experimental studies were conducted to verify the feasibility of this combination of processes with the use of a single upgraded magnetron-type plasma process device. The upgrade was aimed at attaining a high degree of magnetic field unbalance. For this purpose, use was made of an additional magnetic system with an external magnetic coil (outside of the vacuum chamber). The HCPMD was powered using a proprietary low-frequency (100 Hz) switching discharge supply. The local and space characteristics of a gas–metal plasma beam in the drift region were studied. It was confirmed that the plasma beam angle can be varied over a wide range to control the treatment locality degree. The local plasma characteristics attained in the experiments meet the requirements for ion-plasma strengthening treatment. The implantation treatment efficiency was confirmed in a test specimen nitriding experiment, whose results were satisfactory.

***Keywords*:** *ion-plasma technology, high-intensity low-energy ion implantation, nanostructured coating, high-current pulsed magnetron discharge, gas-metal plasma, magnetron sputtering system, pulsed discharge power source.*

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