

Effects of low pressure radio frequency discharge on the physical and mechanical characteristics and chemical composition of diffusion coating on a surface of complex configuration details

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Abstract

© Published under licence by IOP Publishing Ltd. The work deals with the influence of low-pressure radio frequency (RF) discharge on the surface properties of metals and their alloys. As objects of research to study the interaction of the jet low pressure RF discharge into the surface of the material the following materials were chosen: tungsten cobalt alloy, high speed steel, structural steel. In the presence of the materials energy parameters of low pressure RF discharge flows in the discharge chamber and the electrode gap were studied. A quantitative assessment of the gas composition inside the chamber to determine the characteristics of the plasma flow, making the major contribution to the modification of the surface was carried out. The influence of the input parameters of the plasma unit on the discharge characteristics was held. Identification of the main processes responsible for the modification of the surface of metals and alloys with the metal sample in the plasma jet and the effect of samples of products complex configuration on its properties is determined. The results of studies of physical and mechanical characteristics and chemical composition of the surface layers of high-speed steels, alloys and steel before and after treatment by low pressure radio frequency discharges with the instrumental indentation methods and X-ray photo-electron spectroscopy. With the help of the quality control system of the inner surfaces tubular products were studied.

<http://dx.doi.org/10.1088/1742-6596/789/1/012031>

References

- [1] Saifutdinov A.I 2016 Dynamics contraction of DC glow discharge in argon Journal of Physics: Conference Series 669 ed A.I. Saifutdinov, A.A. Saifutdinova, N.F. Kashapov and SA. Fadeev 012045
- [2] Lopatin I.V 2012 Independent glow discharge of low pressure hollow cathode at a current of tens of amperes Plasma physics 38 ed I.V. Lopatin, P.M. Schanin, Y.K. Akhmadeev, S.S. Kowalski and N.N. Koval 639-643
- [3] Zhang C.S 2013 Experimental and theoretical study on interaction between lanthanum and nitrogen during plasma rare earth nitriding Applied Surface Science 1 287 ed C.S. Zhang, M.F. Yan and Z. Sun 381-388
- [4] Semenov A.P 1973 Wear-resistant coatings applied by vacuum ion-plasma methods Technology of mechanical engineering ed A.P. Semenov and A.I. Grigoriev 15-20
- [5] Vasiliev I.I. A device for vacuum coating Patent. 110088 RU the applicant and the patentee Application no 2011113754; application date 08.04.2011; publishing date 10.11.2011
- [6] Brzhozovskii B 2016 Composite ion-plasma coatings with nanodisperse reinforced phase: scientific and practical aspects of synthesis IOP Conference Series: Materials Science and Engineering 116 ed B Brzhozovskii, V Martynov, E Zinina and M Brovkova 01022007

- [7] Smallman R. E 2014 Oxidation, Corrosion and Surface Engineering Modern Physical Metallurgy 8 ed R.E. Smallman 617-657
- [8] Marin E 2016 Diffusive thermal treatments combined with PVD coatings for tribological protection of titanium alloys Materials & Design 89 ed E. Marin, R. Offioiach, M. Regis, S. Fusi, A. Lanzutti and L. Fedrizzi 314-322
- [9] Catalogue of Vacuum technology NPF »Alan Practitioner PVD vacuum coating application methods. Website URL: <http://www.elanpraktik.ru/technology/pdf/pvd-%20metody.pdf> reference date 03/10/2014 - ref-separator -
- [10] German S 2016 Fox-Rabinovicha Hierarchical adaptive nanostructured PVD coatings for extreme tribological applications: the quest for nonequilibrium states and emergent behavior Science and technology of advanced materials 13 ed German S Fox-Rabinovicha, Kenji Yamamoto, Ben D Beake, Iosif S Gershamand, Anatoly I Kovaleve, Stephen C Veldhuis, Myriam H. Aguirref, Goulnara Dosbaeva and Jose L Endrinog
- [11] Pelletier J. 2005 Plasma-based ion implantation and deposition: A review of physics, technology and applications IEEE Transactions on Plasma Science 33 ed J. Pelletier and A. Anders 1944-1959
- [12] Belyakov A.V. 2016 The technology of electric spark for the rotor blades of steam turbines and equipment for its realization resource improvement Electrical stations ed A.V. Belyakov, V.V. Sarantsev, A.N. Gorbachev, F.I. Panteleenko, E.L. Azarenka and B.F. Reutov
- [13] Patent The method of the vacuum tube inner surface processing RU 2039845
- [14] Calanda N.A 2016 Magnetic and magnetoresistive properties of nanoheterostructures Al₂O₃-Sr₂FeMoO₆- δ -Al₂O₃ Physics of solid substance 58 ed N.A. Calanda, G.G. Peas, M.V. Yarmolich, A.A. Lozovenko and E.J. Buzzards 341-348
- [15] Fernandes Frederico Augusto Pires 2013 Microstructure of nitrided and nitrocarburized layers produced on a superaustenitic stainless steel Journal of Materials Research and Technology 2 ed Frederico Augusto Pires Fernandes, Luiz Carlos Casteletti and Juno Gallego 158-164
- [16] Abdullin I.Sh 2008 Proc. of 61st annual gaseous electronics conference ed I.Sh. Abdullin, V.S. Zheltukhin, I.R. Sagbiev and R.F. Sharafiev Surface Layers Modification of Tungsten-Cobalt Alloy by Low Pressure RF Plasmas Abstract: FTP1.00021
- [17] Boniatti Rosiana 2013 The influence of surface microstructure and chemical composition on corrosion behaviour in fuel-grade bio-ethanol of low-alloy steel modified by plasma nitro-carburizing and post-oxidizing Applied Surface Science 280 ed Rosiana Boniatti, Aline L. Bandeira, Angela E. Crespi, Cesar Aguzzoli, Israel J.R. Baumvol and Carlos A. Figueroa 156-163
- [18] Zheltukhin V.S 2007 Proceedings of International Conference «Micro- and Nanoelectronics-2007» ed V.S. Zheltukhin, I.Sh. Abdullin, I.R. Sagbiev and R.F. Sharafiev (Russia: Moscow-Zvenigorod) Low Pressure Radio-Frequency Plasmas in the Nanolayers Formation on the Surface of Construction Materials 32-39
- [19] Kashapov N.F 2015 Hardening of the surface plasma jet high-frequency induction discharge of low pressure IOP Conference Series: Materials Science and Engineering 86 ed N.F. Kashapov and S.N. Sharifullin
- [20] Sharifullin S.N 2009 Plasma method of increasing the roughness class and hardening surfaces of products Bulletin of Samara Scientific Center of the Russian Academy of Sciences ed S.N. Sharifullin, N.R. Adigamov and S.V. Slavnina 15-18 Special. Issue "Actual problems of mechanical engineering"
- [21] Makhotkina L.Yu 2016 Design of special purpose products made of nanomodified leather IEJME-Mathematics education 11 ed L.Yu. Makhotkina, V.I. Khristolubova and L.R. Khannanova-Fakhrutdinova 1495-1503
- [22] Sagbiev I.R 2009 Low pressure radio frequency Jet discharge in the process of surface modification of structural materials nanolayers ed I.R. Sagbiev 332 Kazan Dis. Doctor. Sciences
- [23] Sharafiev R.F 2010 The flow of low pressure radio frequency plasma in the processes of interaction with the surface materials: Abstract ed R.F. Sharafiev 20 Kazan Ph.D. Dis.
- [24] Shaehov M.F 2006 Physics of low pressure radio frequency discharge in the processing of capillary-porous and fibrous materials: Abstract ed M.F. Shaehov 32 Doctor. Science Dis.
- [25] Gaysin A.I 2015 Features of the transition of low-current radio frequency capacitive discharge with an electrolytic electrode to the high-current discharge High temperature 53 ed A.I. Gaysin 18-22
- [26] Markov A.V 2015 Heating of a gas and a polymeric material in low-temperature plasma of a high-frequency discharge High Temperature 53 ed A.V. Markov and Y.P. Yulenets 167-170
- [27] Makhotkina L.Yu 2016 Design of special purpose products made of nanomodified collagen-containing materials with radio-frequency discharge IOP Conference Series: Materials Science and Engineering 134 ed L.Yu. Makhotkina and S.N. Sharifullin 012020
- [28] Abdullin I 2014 State-of-the-art Trends of Scientific Research of Artificial and Natural Nanoobjects: abstracts for 4th International Scientific conference ed I. Abdullin, A. Khubatkuzin and V. Khristolubova Formation of diffusive nanostructured layers on a surface of metals and their alloys 161-163
- [29] Khristolubova V.I 2016 Gas and plasma dynamics of RF discharge jet of low pressure in a vacuum chamber with flat electrodes and inside tube, influence of RF discharge on the steel surface parameters IOP Conference Series: Materials Science and Engineering 134 ed V.I. Khristolubova, N.F. Kashapov and M.F. Shaehov 012017

[30] Oliver W.C 1992 An improved technique for determining hardness and elastic modulus using load and displacement sensing indentation experiments J. Mater Res. 7 ed W.C. Oliver and G.M. Pharr 1564-1580