A Visible and Near-IR Tunnel Photosensor with a Nanoscale Metal and DLC Film Emitter in Strong Electrostatic Field

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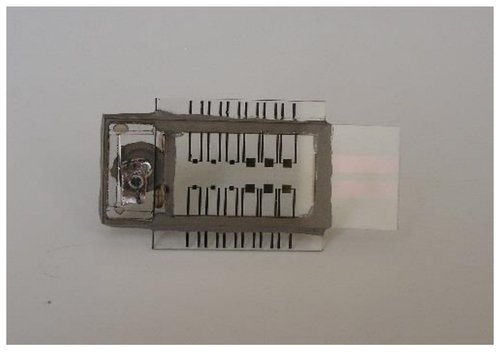
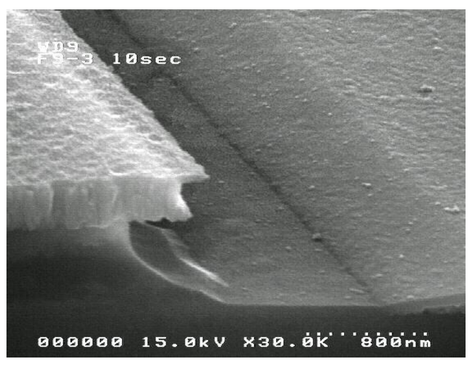
ABSTRACT

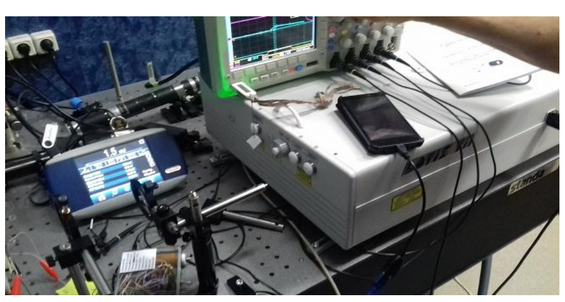
The results of the research and design of a novel vacuum photosensor with a planar molybdenum blade structure are presented [1,2]. The advanced prototype implements the principle of an increasing penetrability of the Schottky barrier for the metal-vacuum interfaces under the action of an external strong electrostatic field. Theoretical and experimental substantiation of the photosensor performance in a wide range of wavelengths (from visible to near infrared ones) beyond the threshold of the classical photoelectric effect is given.



Microdiode with an electrostatic field localized at an emitter based on a nanodimensional carbon structure.



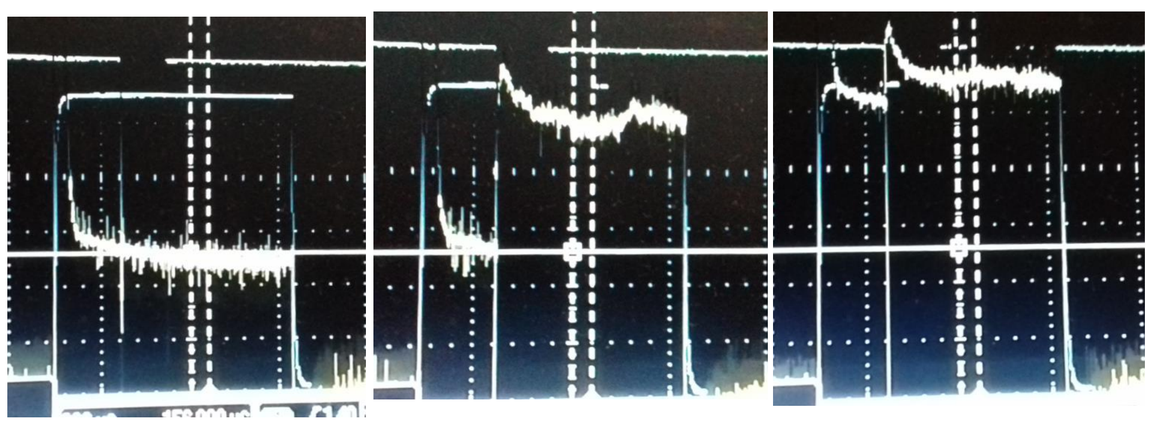
TEM image of the vacuum photosensor with DLC film+Mo emitter.



Laser (400-2000 nm) experimental setup.

Time dependence of the total pulsed field emission current and tunneling photocurrent during laser irradiation of a vacuum microdiode, wavelength 532 nm, pulse energy 10 mJ, pulse duration 10 ns, laser spot area 0.3 cm^2. Voltage pulse 55.2 V, duration 1 ms. Field emission current 8 µA, photocurrent 0.64 µA.

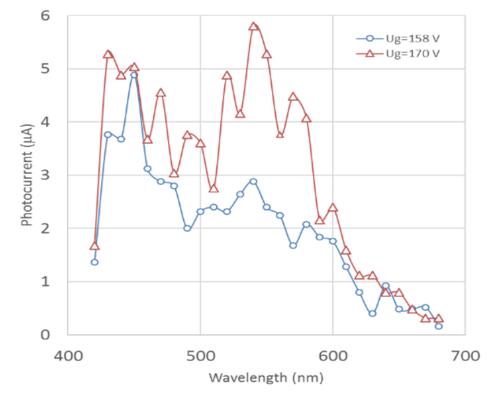
Evolution effect of tunnel electron photoemission from diamond-like carbon film



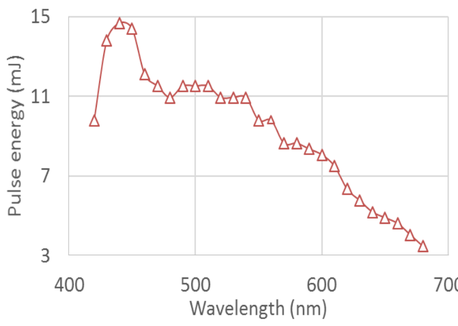
(a) (b) (d)

Experimental dependences of the field and photoemission tunneling current on pulsed (500 ms) voltage at the emitter with the DLC film+Mo irradiated by pulse-wave laser with λ = 555 with an output energy W=10 mJ duration 10 ns.

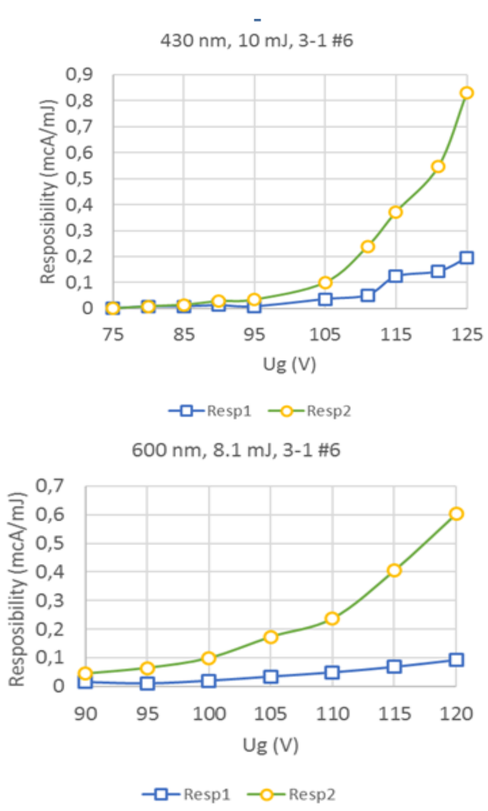
a - field emission during pulse of electrostatic field; b – during first laser pulse; c – during tenth laser pulse.



Mo

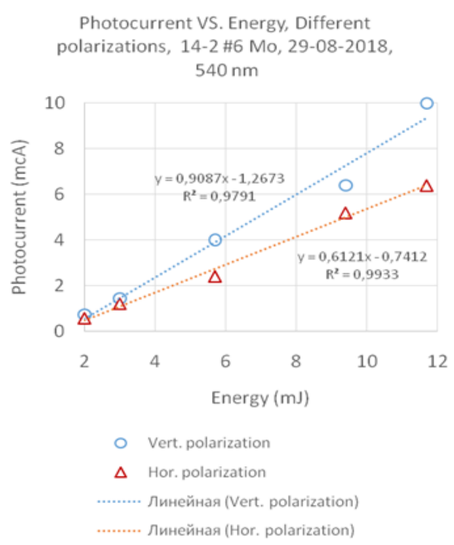


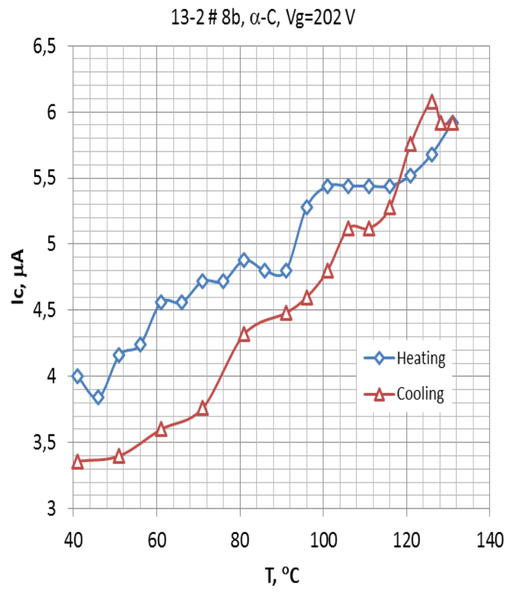
Tunnel electron photoemission in the nanoscale Mo-blade structure with electrostatic field localization under pulsed (10 ns) laser radiation.



DLC film+ Mo

Experimental dependences of the photoemission tunneling current on the difference voltage at the emitter with the Mo and DLC film+ Mo the anode of photosensor irradiated by pulse-wave laser with λ =430, λ = 600 nm with an output energy W= 10 mJ.





Temperature hysteresis effect of tunneling field emission current in DLC film.

1. Yakunin, A.N.; Aban'shin, N.P.; Avetisyan, Y.A.; Akchurin, G.G.; Akchurin, G.G., Jr.; Loginov, A.P.; Morev, S.P.; Mosiyash, D.S. Stabilization of Field- and Photoemission of a Planar Structure with a Nanosized Diamond-Like Carbon Film. *J.Commun. Technol. Electron.* 2019, **64**, 83–88. doi:10.1134/S1064226919010133.

2. Alexander Yakunin, Nikolay Aban'shin, Garif Akchurin, Yuri Avetisyan, Alexander Loginov, Sergey Yuvchenko, Sergey Zarkov, Sergey Volchkov, and Dmitry Zimnyakov, A Visible and Near-IR Tunnel Photosensor with a Nanoscale Metal Emitter: The Effect of Matching of Hot Electrons Localization Zones and a Strong Electrostatic Field. *Appl.Sci*. 2019, **9(24)**, 5356. DOI: 10.3390/app9245356.

CONCLUSIONS

The tunneling linear photoelectric effect in a planar vacuum microdiode under laser irradiation of an emitter representing an interdigital blade-type structure made of molybdenum and with a deposited diamond-like carbon nanofilm 10-30 nm was experimentally discovered and studied in detail in a strong electrostatic field in the visible and near-IR spectral range 400 nm-1200 nm. The influence of the temperature regime on the emission properties of a vacuum diode is estimated.

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