BOOK OF ABSTRACTS

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IEP-2025

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МАТЕРІАЛИ КОНФЕРЕНЦІЇ

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Збірник містить анотації до доповідей, представлених на Міжнародній конференції молодих учених та аспірантів ІЕФ-2025. Доповіді присвячені дослідженню явищ при електронних і атомних зіткненнях; елементарних процесів у лазерах і низькотемпературній плазмі; спектроскопії атомів, молекул, кристалів і невпорядкованих систем; нанотехнологій і наноструктур; матеріалів функціональної електроніки; ядерної фізики, радіаційної фізики і ядерної безпеки, радіоекології; теоретичної фізики.

The book includes abstracts of talks presented at the International Conference of Young Scientists and Post-Graduate Students IEP-2025. The talks are devoted to the studies of phenomena at electron and atomic collisions, elementary processes in lasers and low-temperature plasma, spectroscopy of atoms, molecules, crystals, and disordered systems, nanotechnology and nanostructures, materials for functional electronics, nuclear physics, radiation physics and nuclear safety, radioecology, and theoretical physics.

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CHARACTERISTICS AND CONDITIONS OF PULSE GAS-DISCHARGE SYNTHESIS OF THIN FILMS OF NICKEL OXIDE (NiO)

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Nickel oxide nanostructures are widely used in microelectronics, nanotechnology, medicine and biology. In particular, in [1] the results of the manufacture and application of dye-sensitized photocathodes from NiO were reported.

The report presents the results of a study of the conditions and characteristics of the synthesis of thin films of Nickel oxide by their deposition from an overvoltage nanosecond discharge (OND) plasma between Nickel electrodes in atmospheric pressure oxygen.

OND characteristics: voltage and current oscillograms on the discharge chamber electrodes, radiation spectra, oscillograms of the most intense spectral lines and bands were performed using the stand described in [2]. The distance between the electrodes, which were made of Nickel, was d = 2−3 mm. The discharge was ignited using a bipolar voltage pulse generator with a duration of 100−150 ns and an amplitude of ±(20−40) kV. The repetition rate of the voltage pulses could vary in the range of 40−1000 Hz. Under such OND ignition conditions, it existed in an overvoltage mode, when favorable conditions were created there for the generation of "runaway electrons" and the accompanying ultrasoft X-ray radiation. As a result of these factors, which played the role of the automatic pre-ionization system of the discharge gap, a spatially uniform discharge in the form of a ball with a diameter equal to the distance between the electrodes was ignited. The introduction of Nickel vapor into the discharge gap occurred due to the formation of ectons on the surface of the electrodes. Once in the plasma, Nickel vapor entered into plasma-chemical reactions with Oxygen and its decomposition products in the plasma to form clusters and nanoparticles of Nickel oxide. Due to the gas-dynamic expansion and scattering of the formed nanoparticles on the dielectric substrate installed near the electrode system, thin films of Nickel oxide were deposited.

At atmospheric pressure of Oxygen and frequency f = 80 Hz, the amplitude of voltage of one polarity on the electrodes was reached in the initial stage of the discharge and was ≈ 15 kV, and the current was about 200 A. The maximum pulse power of the discharge reached ≈ 4 MW, and the energy in a single electric pulse was 176 mJ.

Fig. 1 and Table 1 show the characteristic emission spectrum of the gas-vapor mixture "O2 - Ni" when excited in the OND with ectonic introduction of Nickel vapor into the plasma and the results of its identification in the spectral range 200 − 450 nm.

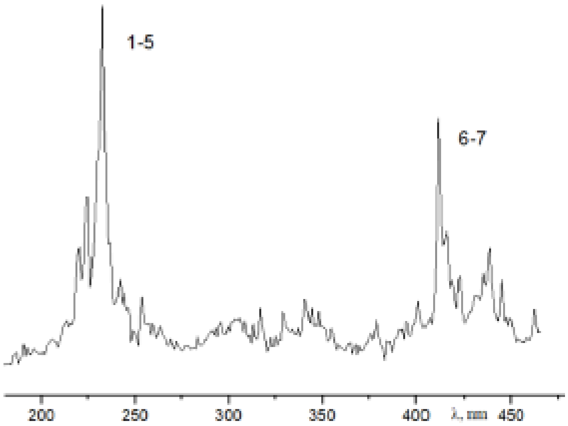

Figure 1. OND emission spectrum between Nickel electrodes at an atmospheric pressure of Oxygen of 1 atm (f=80 Hz, d= 2-3 mm).

Table1. Results of identification of the emission spectrum of OND plasma between Ni electrodes at an atmospheric pressure of Oxygen (d=2 mm; f=80 Hz).

№	λ_{table}, nm	I_{exp} a.u. од.	Object	E_{low}, eV	E_{high}, eV	Term low	Term high
1	219.73	46	Ni I	0.21	5.85	$3d^9(^2D)4s\ ^3D_1$	$3d^8(^3P)4s4p(^3P^o)\ ^3P^o_1$
2	224.45	65	Ni I	0.109	5.631	$3d^9(^2D)4s\ ^3D_2$	$3d^8(^3F)4s4p(^1P^o)\ ^3F^o_2$
3	232.00	138	Ni I	0	5.34	$3d^8(^3F)4s^2\ ^3F_4$	$3d^8(^3F)4s4p(^1P^o)\ ^3G^o_5$
4	241.93	34	Ni I	0.165	5.28	$3d^8(^3F)4s^2\ ^3F_3$	$3d^8(^1D)4s4p\ (^3P^o)\ ^3D^o_2$
5	300.24	19	Ni I	0.025	4.15	$3d^9(^2D)4s\ ^3D_3$	$3d^8(^3F)4s4p\ (^3P^o)\ ^3D^o_3$
6	409.59	93	O_2	$B^3\Sigma\rightarrow X^3\Sigma$ (1,19)			
7	437.26	79	O_2	$B^3\Sigma\rightarrow X^3\Sigma$ (2,21)			

In the ultraviolet region of the spectrum, only the spectral lines of the Nickel atom were observed. The most intense of them was the resonant spectral line at 232.00 nm. No NiII spectral lines were detected. This distribution of the intensity of the NiI spectral lines (see table) is consistent with the distribution of the effective cross sections of excitation of these lines by direct electron impact [3]. The dynamics and results of the synthesis of films based on clusters and nanoparticles of Nickel oxide are planned to be carried out using the XploRA PLUS Raman scattering spectrometer.

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