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EMISSION REGISTRATION ON FILMS DURING GLOW DISCHARGE EXPERIMENTS

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ABSTRACT

Deuterium and protium experiments in the glow discharge apparatus were conducted with U, W, Zr, Pd foils placed on the cathode. The glow discharge apparatus contains two concentric quartz tubes, each with about five mm wall thickness. Kodak BioMax MR-2 films (13x18 cm) contained in individual packets are intended to detect gamma and x-ray emission in the energy range from 150 to 260 keV. The films were placed against the outer quartz tube about 70 mm from the electrodes during glow discharge operation time ranging from 1-25 hours. The applied glow discharge voltage during was 200-700 V, the current was 5-25 mA/cm^2, and the gas pressure was 2-5 torr.

After films development the unusual tracks shapes were observed on films, which had been exposed to deuterium ion plasma, but no tracks were found on films, exposed to hydrogen ion plasma. These results were obtained using either tungsten or uranium cathodes with cold cathode (<100^{o}C). No the diffuse scattering blackening of the x-ray films was observed. The images on the films often consisted of a set of black points, joint together by the gray wide discrete lines like concentric segments, which were distributed equidistantly.

These images were situated in the zone near electrodes ± 30 mm. Presumably the zone of the reflection or re-reflection of some emission. The periodical structure of these images can allow the wave function of this emission.

Probably the reason of these tracks is X-ray (as secondary emission) reflection and re-reflection from the electrode grains aggregate (like from monocrystals) with loss of part energy or from secondary electrons clusters from cathode after blisters break, or from cathode metals clusters. The energy range for β emission penetration must be above 166 keV, the proton energy range for penetration through 6 mm Quartz tube must be above 300 keV.

It is not clear about the reason of such kind of tracks on the films. Wave resonance structure of these images requires the additional research. Continuous investigation is necessary to explain these facts.

1. INTRODUCTION

The phenomenon accompanying the glow discharge burning was studied for more than 20 years[1,2]. The defects, which were similar to the defects formed in the cathode material structure, were observed after hydrogen, argon and helium glow discharge with ions energy less then 1000 volts. The physical and mechanical properties of the material after and during the glow discharge experiment had the significant changing in the metal on the few millimeters depth. The neutron and charged particles emission, x-ray emission, the chemical structure change and the isotopes ratio change in the cathode materials, heat effects under certain conditions were observed during Deuterium and Hydrogen glow discharge (GD) and after GD experiments switch off[3-5]. There is a lot of data published on chemical and isotopic structure of the cathode materials by groups of Prof. G. Miley, Mizuno, and Dash and others after light and heavy water solutions under electrolysis[6, 7, 8].

In our previous experiments with deuterium glow discharges excess heat, neutron, gamma, charged particle emission, isotope shift and element yield have been observed[3-8].

The change of radioactivity in the Uranium cathodes after electrolysis and after glow discharge experiments was studied this year[6]. The processes in the glow discharge plasma are accompanying by some emission[3, 5,7]. The attempt to estimate the character of this emission during this research was made.

2. GLOW DISCHARGE DEVICE AND PARAMETERS

The Glow Discharge installation represents a vacuum chamber with a capacity of $1 \cdot 10^{-3}$ m. Incorporated into the chamber are the water cooled changeable cathode and anode units, gas pumping and filling systems, power supply. The installation is provided with a set of instruments to register the process

parameters (current and voltage, residue media and working gas pressure) and the cathode thermocouples. The single or double Quarts tubes were used as walls of the chamber. The distance between the anode and the cathode scan was ~ 3-5 mm. The chamber pressure values amounted to 10^{-1}-10^{-2} Torr for evacuation and 10^{-1}-5 Torr when filled with working gas, respectively. Protium and Deuterium were used as working gases. The flow of the working gas was used always. The gas pressure in the vacuum chamber was 2-5 torr. The samples were exposed to irradiation at the current of 10- 25 mA and the Glow-Discharge voltage of 500-700 Volts. The duration of the x- ray films exposure in the glow discharge lasted from 1 to ~25 hours.
The main GD parameters are presented in Table1.

The samples measured ~20 mm in diameter, 100 - 200 μkm in thickness, ion bombardment area of the samples was ~ 1 cm^2. The samples were placed on the stainless steel cathode-holder and were pressed by Molybdenum nut. The thermocouple is located between the stainless steel cathode-holder and the sample. Molybdenum anode nut was also used. The stainless steel cathode-holder and the anode- holder respectively were placed inside the quarts tubes. The thickness of the SiO_2 tubes were ~ 6 мм.
The cathode temperature was measured by the especially devised K type thermocouple, located inside stainless steel capillary and isolated between wires and capillary by Al_2O_3 powder. The said thermocouple has the thin ending, allowing a good contact with the sample and the cathode-holder.
The sample was pressed by a Molybdenum nut, screening the stainless steel cathode-holder from the Glow Discharge plasma. This design of the cathode-holder and thermocouple does not allow any contact and to penetration of the chemical elements from both (of the cathode - holder and the thermocouple) inside Glow Discharge zone. The diagram of the chamber is presented in Ref. 6. We used the W, Zr, Pd and Uranium with purity 99,9% (Good Fellow, England) foils as cathode samples.

3. BIO -MAX MR FILMS METHOD.

X-ray Kodak Bio -Max MR films were used for some emission registration during the Glow Discharge bombardment. Kodak Bio -Max MR films (with maximum resolution) have a size 13x18 cm. The films, contained in individual packets, were placed out side the apparatus during the glow discharge operation ranging 1-25 hours.
The recommended maximum resolution of these films for gamma emission is within the energy range of 0.150 - 0.250 MeV. The gamma emission with such energy level can be register by BioMax MR films. The distance between the cathode-anode axis and the films was ~ 60 millimeters (40 mm inside the Deuterium or Hydrogen plasma, 6 millimeters of the SiC tubes thickness and ~12 millimeters of the air layer). Films were processed after experiments under standard methods using the standard developing procedure according manual processing protocol: 5 minutes treatment to the developer, the rinse, 5 minutes in the fixer, then washing and drying. The diagram of the films placed outside the apparatus is shown in Fig.1.

4. RESULTS

Fig.2 illustrates the images formation (in the decreasing size) on the three films and places of their location for these three films, exposed during Uranium-Deuterium experiment.

The traces were observing in the zone between the electrodes, placed near the center of the apparatus ~± 30 mm from electrodes. The traces had different intensity from black to gray color and different shape. The black traces had the sharp boundaries and the gray traces boundaries were not the sharp (Fig.3).

The following kinds of traces were observed: the biggest size traces, the middle size traces of the round shape and the traces of the small size (the points or double points). The traces often looked like as the parts of spirals. The lines of separate black points were jointed together as solid wide gray line. Sometimes they looked like separate points set on the concentric rings.Biggest tracks with maximal size up to ~ 30 mm can be seen, as combinations of small sharp points (traces), the components or the segments of the spirals. The axes of these spirals and double spirals were displaced and sometimes turned one to another at different angles. Fig.4 shows the image on the film after Uranium experiment in Deuterium. Fig.5 shown similar images on the two perpendicular by placed films, one image look like overlapped on the other film for the Tungsten sample with Deuterium plasma. The figures with the symmetric spin structure, located perpendicularly with regard one to another.
Fig.5a is the magnified fragment of Fig.5 with the detail presentation of this image.

The next experiments with x-ray films using Uranium and other metals were conducted:

Table1 PARAMETERS OF THE GLOW DISCHARGE EXPERIMENT WITH X-RAY FILMS USING

#	Cathod	Media	Voltage,	Current,	Cathode	Film number	Time of	Images

	e sample		V	mA	sample maximal T, °C		exposure, Hours	formation
2	**W**	**Air**	**550±50**	**13±2**	**22**	**2**	**22**	**No**
3	**W**	**H**	**800±200**	**15±5**		**3/1**	**5.5**	**No**
	W	**H**	**660±5**	**20**		**3/2**	**16.5**	**No**
4	**W**	**H**	**720±50**	**12±2**		**4/1**	**18.5**	**No**
	W	**H**	**750±5**	**7**		**4/2**	**1**	**No**
5	**W**	**D**	**475±5**	**16±2**	**120**	**5/0**	**1**	**No**
	W	**D**	**570±40**	**12±4**	**65**	**5/2**	**5.5**	**Yes****
6	**U (1)**	**D**	**570±5**	**8±2**	**50**	**6/5; 6/6; 6/7**	**3.25**	**Yes****
	U (1)	**D**	**620±25**	**22±3**	**230±30**	**6/8; 6/9****	**5**	**No**
11	**U (4)**	**D**	**550±50**	**9±1**	**70±10**	**11/1; 11/2***	**2.5**	**Yes****
7	**U (2)**	**H**	**575±75**	**10±5**	**50±10**	**7/1; 7/2; 7/3**	**21**	**No**
	U (2)	**H**	**575±75**	**8±2**	**100±50**	**7/4 7/5a,b*;**	**25**	**No**
8	**U (3)**	**H**	**600±100**	**15±5**	**150±50**	**8/1a,b*,8/2a,b***	**18**	**No**
9	**Zr**	**H**	**600**	**13±3**	**200**	**9/1*; 9/2***	**46**	**No**
10	**Pd**	**H**	**600±50**	**18±2**	**250**	**10**	**2**	**No**

* Two films, jointed together (||), other films were placed perpendicularly (⊥)

** Double marks are noted the films with biggest spiral images formation.

Sometimes the nearest tracks (or systems of traces) look as located at different levels (one under another) (Fig.5a), but there is only one emulsion layer in these Kodak Bio-Max MR films. presumable, it means, that the different images formed at different moments on the nearest places of the films from crystals, which located on the electrodes side by side.

5. DISCUSSION

The main points of table 1 and the films analysis are following:

- The images formation on the x-ray films took place only during deuterium bombardment
- The images formation on the x-ray films was observed only for the cooled cathode with temperature less 100 °C
- The images on the two films, which were placed perpendicularly (⊥) overlap one another.

The biggest images on the x-ray films appeared in experiments with the following parameters: the voltage ~600 volts and current ~0.01 Amperes.

After the development films the unusual shape of tracks were observed on films, which had been exposed to deuterium ion plasma, but no tracks were found on films, which had been exposed to hydrogen ion plasma. The small sharp points ~1 mm size on the film after hydrogen experiment were observed seldom.

So, the results were obtained using either tungsten or uranium cathodes with cold cathode.

The diffuse scattering blackening was not observed. The images on the films often consisted of a set black points, jointed together by the gray wide lines like concentric segments, which were distributed equidistantly. These images were situated in the zone near electrodes axis on the distance ± 30 mm.

Possibly, the observation of the segments of spiral toroidal and helical complexes could be the result of the specific electromagnetic fields, formed during some micro explosions under the glow discharge.

Probably the reason of these tracks is the X-ray (as secondary emission) reflection and the re-reflection from the electrode grains aggregate (like from monocrystals) with partial of energy or from secondary electrons clusters from cathode after breaking of the blisters on the cathode surface, or from cathode metals clusters, which could be evaporated during microexplosions.

We can assume the kind of emission registered on resulting films from various kind irradiations: photons, electrons, ions or neutrons.

If it is β emission, then β emission can penetrate go the Quartz tubes (6 mm) only in the energy diapason more than 150 keV. It is not the initial β- emission from decay of U235 and U238 for Th231, Th234 or Pa 234 and Pa234m, because there are the discrete lines and they do not result from the scattering emission (diffuse reflection) on the films. If it is the result of the proton clusters passing the Quartz tube, in such case its energy must be more than 250- 300 keV. Possibly, it means that these tracks can result from the X-ray reflection or re-reflection with partial loss energy. If it is the secondary Bragg reflection (diagram Fig.1), then the loss of energy after X- ray reflection is ~ 0.50 for Mo electrodes and 0.25 for re-reflection.

The reason for the said tracks on the films is not clear. It can be the secondary electrons clusters. It can be secondary X-ray reflection or re-reflection from clusters, break away from the electrodes surface. If we suggest the existence of neutron component in the nuclear reaction, it is necessary to take into account the absorption section value for hydrogen being 700 hundred times more than for deuterium, and the penetration through hydrogen been not real. We didn't observe the biggest coherent tracks after the hydrogen experiment.

It can result from some very fast melting process during the microarcs or micro explosions formation. It should be noted that the first sharp maximum in the heat output during deuterium glow discharge was observed for the same parameters (small current and small cathode temperature)[6]. The possible reasons for the occurrence of the phenomena with big probably energy output and possible constructive reflection on the x-ray films are being discussion.

Instability of plasma is the first reason, which can lead to microexplosions, microarcs (burst, sparks on the cathode surface). The same effect can be observed from inhomogeneous surface with conics and whiskers formations. Second reason can be the blisters formation under surface during the irradiation by high-density low energy ion. Result of proton (deuteron) clusters output from blisters formation and decay in the process like the process in the first wall of the thermonuclear reactor. It can be the result of clusters output of the cathode particles as consequence of the nuclear reactions in the zone of the microexplosion – microexplosion emission. The plasma instability leads to the crystal lattice excitation and increases the probability for emission generation of proton (deuteron), electron, x-ray and neutron component. The possibility of the nuclear reaction and output of the neutron component are higher in the deuterium as the result of the biggest adsorption section and lower of the scattering section in the hydrogen for the comparison with deuterium. The formation of some images on the x-ray films was observed earlier inside and outside the glow discharge plasma[10] and during the electrolysis method by T. Matsumoto[11].

The possibility of the higher efficiency neutron and hard x-ray generation- magnify the effect was shown in the vacuum discharge with deuterium as the result of the multi reflection inside cluster, which was formed in interelectrode space[12].

6. CONCLUSION

- BioMax MR Kodak films shown the reflexes of tracers of the unusual forms observed only for Uranium and Tungsten cathode samples in the Deuterium Glow Discharge exposure with cooled electrodes.
- Its location was preferably near cathode-anode on the ± 30 millimeters distance from the interelectrode axis.
- The figures with the symmetric spin structure overlapped on the other film, located perpendicularly with regard one to another.
- The geometry of images is allows estimating them as systems of reflection from the clusters of grain from cathode and (or) anode.
- It is not clear what kind of emission had really prevailed in the process of the images formation on the x - ray films. Nevertheless, it is possible to suggest, that it looks like a high-energy component registration under the low energy influence.

The complex of the data, which were observed during research under glow discharge plasma's interactions in the PSU (uranium α, β, γ emission changing) and the previous data[3-7], allowed to suggest a strong electromagnetic field emanation resulting from high-energy process generated under initiation by lower energy influence.

ACKNOWLEGEMENT

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FIGURES

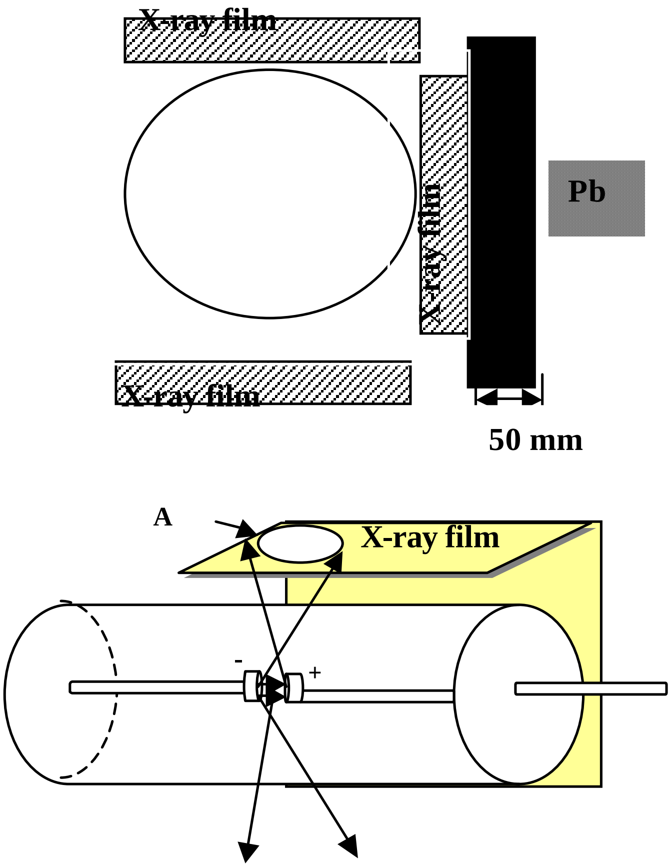


Fig. 1 Diagram showing where the x – ray films were placed (A-zone of the images formation)

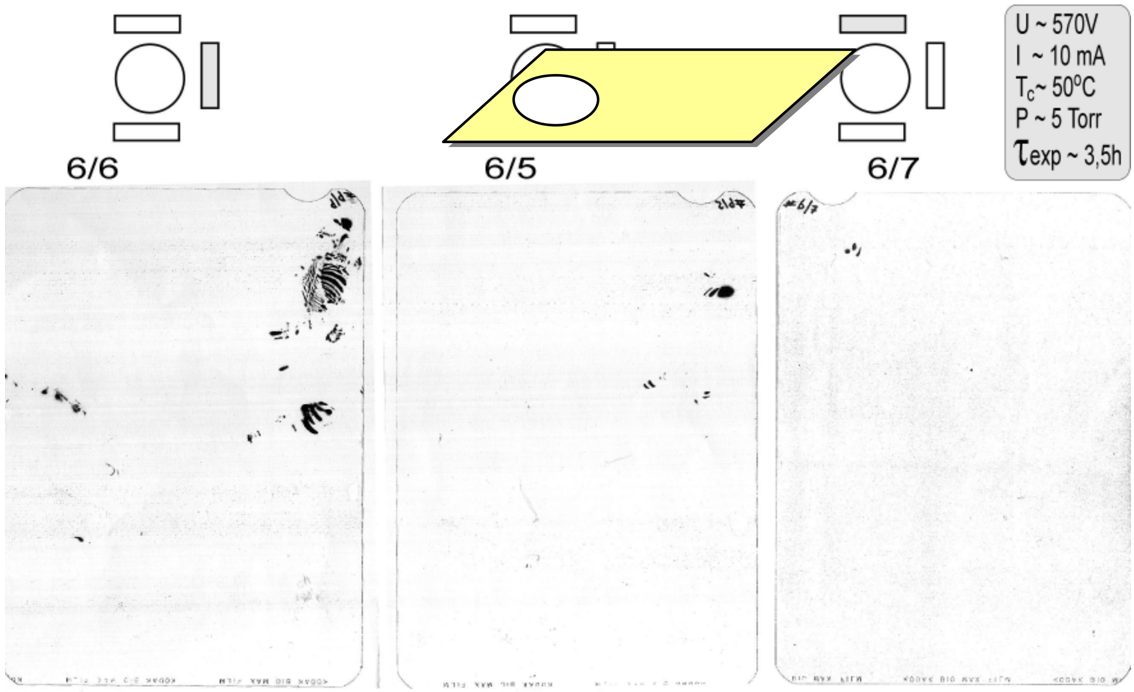


Fig2 Images on the films during one of the uranium-deuterium experiment and diagrams of its placing

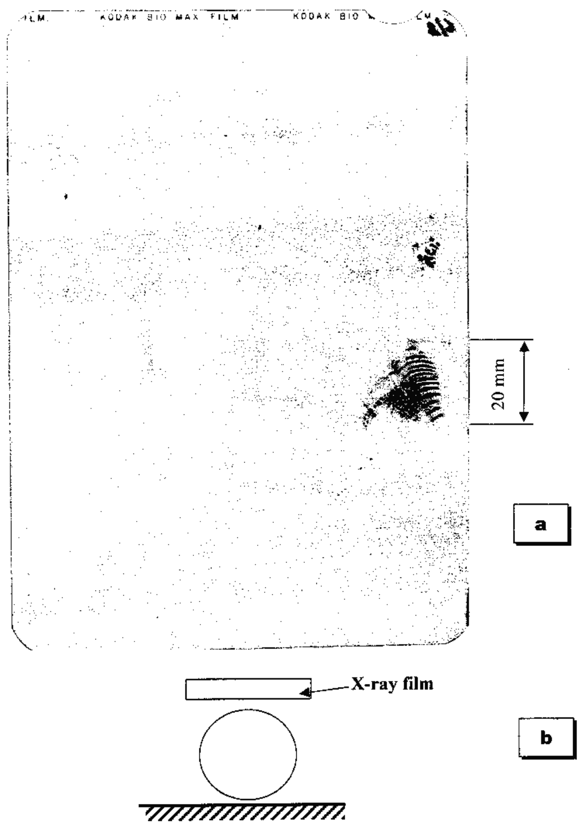
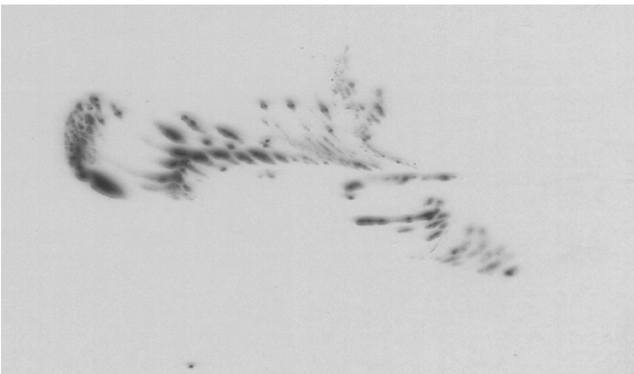


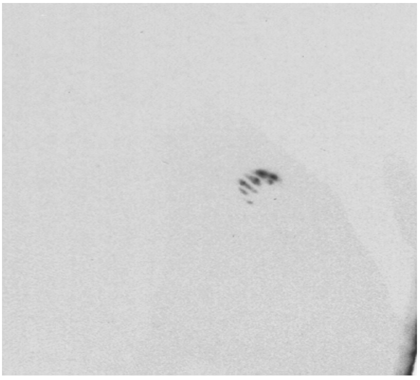
Fig. X-ray film after U-D experiments (#6\2)
τ_{exp} = 4 hours, U≈500V, I ≈10 mA, T_K ≈ 50°C

a – film; b - diagram of the film place

Fig 3



A



B

Fig.4 The fragment of the X-ray film after Uranium-Deuterium experiment
A - zone of reflection (~25 mm),B - zone of reflection(~3 mm)

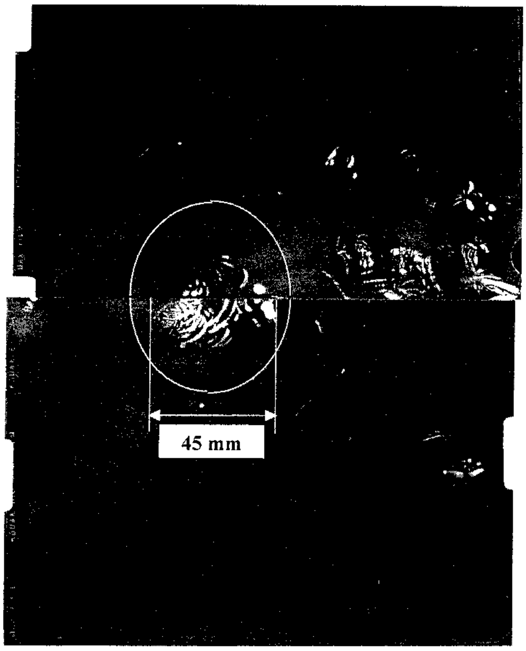


Fig.

Positive image for two (⊥) X-ray films of W-D experiment

Fig5a