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BALMER ALPHA LINE SHAPE AND SURFACE MORPHOLOGY DURING DEPTH PROFILING ANALYSIS OF THIN FILM

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Abstract. The results of the H_α line shape analysis during depth profiling of zinc thin layer at steel surface (commercial name of materials: galfan and galvanneal) are presented. Changes of the H_α line shape are detected during depth profiling of thin layer in Grimm discharge. An attempt is made to correlate the H_α line shape changes with surface morphology recorded with Atomic Force Microscope (AFM).

1. INTRODUCTION

The shape of Balmer alpha line emitted from a low-pressure gas discharge operated with inert gas-hydrogen mixture exhibits unusual multi component structure (see Gemišić et al. 2003, Šišović et al. 2005) The narrowest part of profile with the Doppler temperature not exceeding 1 eV, and of the middle part of the line profile, with the Doppler temperature less then 10 eV, are related to excited H* atoms generated in collisions of high- energy electron with H_2 molecule.

The profile of the hydrogen Balmer lines, recorded end-on from the Grimm discharge in H_2 and hydrogen-inert gases mixtures, are asymmetric. The explanation of the broadest part-asymmetric pedestal of the line profile comes from the sheath-collision model, see e.g. (Gemišić et al. 2003)and references therein. In this model ions H^+ and H_3^+ are accelerated in a high-voltage cathode sheath and produce fast H atoms in charge transfer/dissociation collisions with the matrix gasmolecular hydrogen. The fast H atoms are then excited and scattered in another collision. The same excitation process is occurring with H atoms backscattered from the cathode. In the Ar-H_2 discharge, the contribution of H^+ion is negligible in comparison with that of H_3^+ion.

The latter ion is fragmentized in collisions with matrix gas or at the cathode where generating H_f atoms of lower energy, and consequently lower energy excited atoms H^* are produced in collisions with matrix gas.

2. EXPERIMENTAL

The Grimm type discharge (anode diameter - 8 mm) is used. This discharge operates in a DC mode using a current stabilized power supply ($0 \div 2$ kV, $0 \div 100$ mA). The

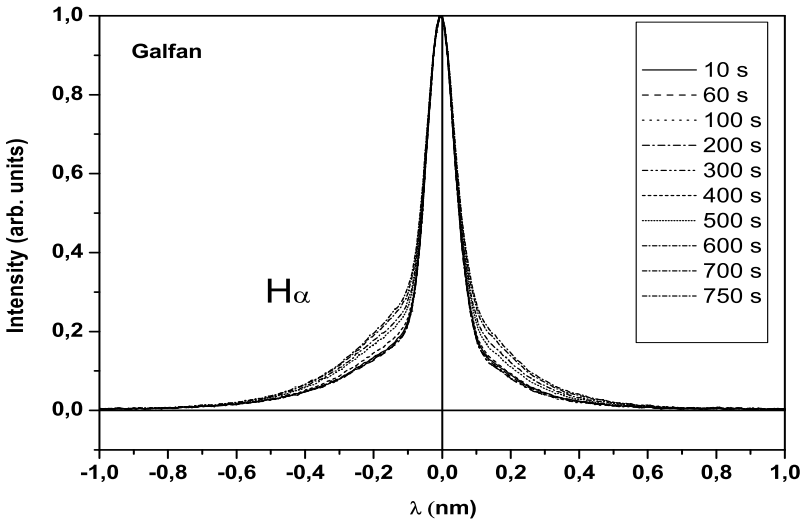

Figure 1: Galfan: The H_α profile versus time of depth profiling;current 42 mA, voltage 780 V and discharge pressure 4,4 mbar.

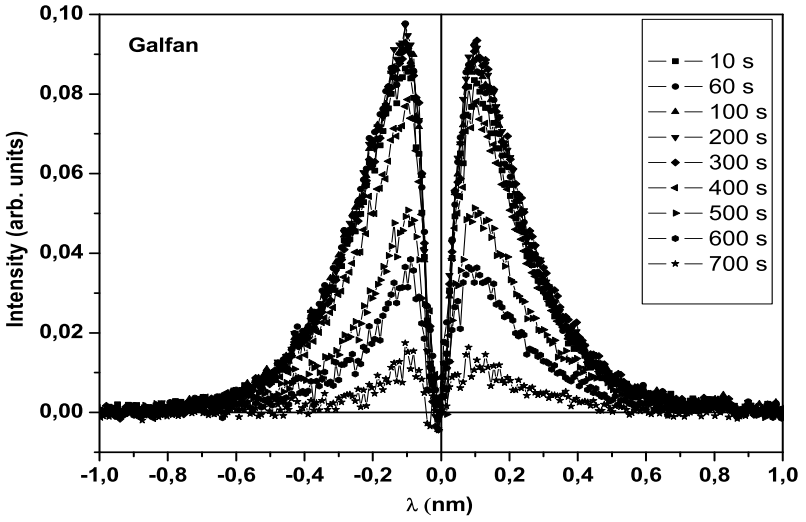

Figure 2: Galfan: Same as in Figure 1 but presented as difference between line profiles in different times of depth profiling.

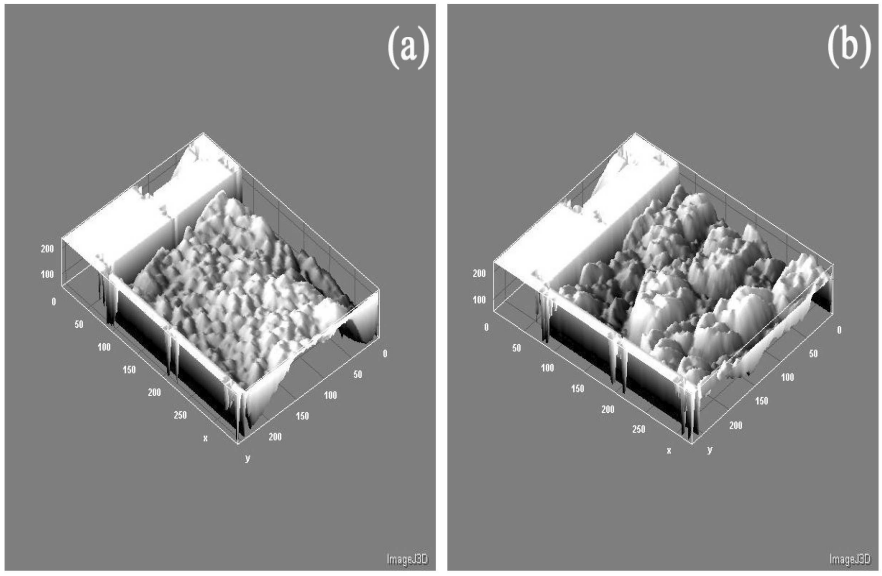

Figure 3: Galfan (i= 42 mA, U=780V, p= 4,4 mbar): (a) sputtering with Ar gas, (b) sputtering with Ar+0.5 %H_2 (AFM).

ballast resistor of 5 kΩ is placed in series with the discharge and DC power supply. During depth profiling current and voltage were kept constant. Since we used constant current power supply, small variations of voltage are corrected with adjustment of pressure (Bengtson et al. 2006). The discharge anode was grounded.

The double stage mechanical vacuum pump insured differential pump out of discharge source. The capacitive pressure gauge was used for pressure measurement in the Grimm source. In this experiment working gas was either pure Ar or gas mixture Ar +0.5 % H_2 vol.

The light along axis of Grimm lamp is focused by an achromat lens (75, 8 mm) onto the entrance slit of spectrometer. To record line spectra 2 m Carl Zeiss PGS-2 spectrometer and CCD detector (Toshiba 1304USB, 3648 channels) is used. The instrumental profile was Gaussian like having full half-width of 0.018 nm. Signals from CCD detector were A/D converted and processed by PC.

3. RESULTS AND DISCUSSION

The object of consideration was hydrogen Balmer alpha line. The shape of this line was recorded at different times of depth profiling and an example for Galfan is presented in Figure 1. Small differences of line shape during depth profiling are evident. In order to illustrate better these changes the difference between line shapes recorded at 10 second and several later times are presented in Figure 2. The AFM photos of thin layer surface for Galfan and Galvaneal are given in Figures 3 and 4, which show changes of the surface structure during depth profiling. Presently attempt

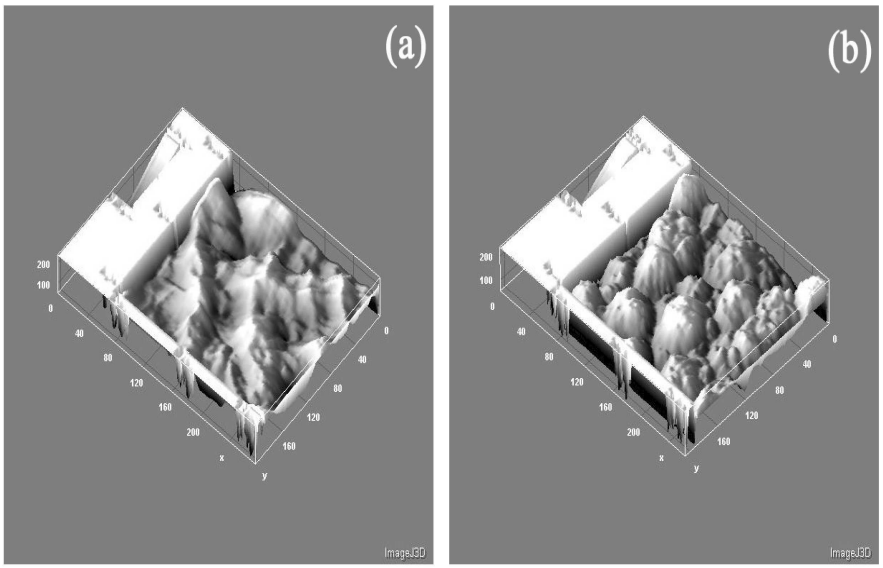

Figure 4: Galvanneal (I=42 mA, U=760V, p=4,4 mbar): (a) sputtering with Ar gas, (b) sputtering with Ar+0.5 % H_2 (AFM).

is beginning made to correlate line shapes, Figure 1 and 2 with surface structure of material, Figures 3 and 4.

Acknwoledgements

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References

Bengtson, A., Nelis, T.: 2006, *Analitical and Bioanalitical Chemistry*, **385**(3), 568.
Gemišić-Adamov, M. R., Obradović, B. M., Kuraica, M. M., Konjević, N.: 2003, *IEEE Trans. Plasma Sci.*, **31**, 444.
Šišović, N. M., Majstorović, G. Lj., Konjević, N.: 2005, *Eur. Phys. J. D*, **32**, 347.