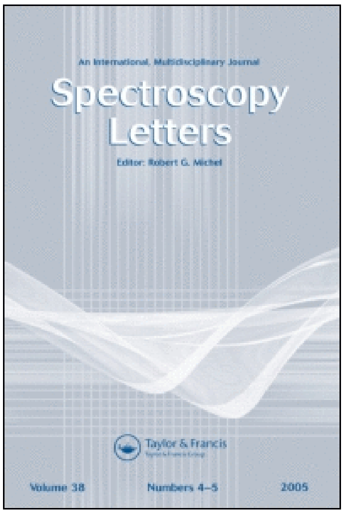

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Optogalvanic Diagnostic of Conical Bottom Hollow Calhode Discharge. Enhancement of the Optogalvanic Signal

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OPTOGALVANIC DIAGNOSTIC OF CONICAL BOTTOM HOLLOW CATHODE DISCHARGE. ENHANCEMENT OF THE OPTOGALVANIC SIGNAL

Key words: Optogalvanic Response, Hollow Cathode Discharge

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ABSTRACT

We present an optogalvanic aspect of a new modification of Hollow Cathode Discharge (HCD), i.e. conical bottom HCD. Earlier we found this modification enhancing the light emission properties of the conventional flat bottom HCD; a greater concentration of sputtered atoms was established by using a level crossing method. This effect provoked us to investigate the conical bottom HCD as an optogalvanic detector of signals, belonging to the sputtered atoms in the negative glow. The conical bottom HCD is found to be an effective optogalvanic detector due to the structure of the radial distribution of the optogalvanic signal.

INTRODUCTION

The discharge in a new modification hollow cathode lamp, i.e. Conical Bottom (CB) modified Hollow Cathode Discharge (HCD) was studied in detail in Ref. [1]. The replacement of the flat bottom with the conical one provides some new advantages of this light source. First of all an increased emission of the sputtered atom spectrum was observed. Later these advantages of CBHCD were confirmed and verified for some couples "cylinder - cone" made from various metals [2]. The narrowed signal in Hanle experiments indicates an additional generation of sputtered atoms in CBHCD [3].

This report contains some results of Optogalvanic (OG) diagnostic of CBHCD. The amplitude of the signal is treated as a sensitive probe for the sputtered atoms of the cathode surface. Comparative OG measurements in the conventional (flat bottom)- and CB- HCD are performed.

EXPERIMENT

It is important to avoid the interfering photoemission OG effect due to laser beam - surface interaction. That is why the negative glow is irradiated through the coinciding radial slits (1 mm) in the flat- and conical- bottoms. From this point of view the CBHCD arrangement in FIG.1 is used. The flat bottom hollow cathode (length: 30 mm, radius: 3mm) and the cone inserted (high: 20mm) are made from cooper. Its conical part may be dismantled without opening of the glass tube. In this way measurements in a conventional (flat bottom) HCD may be performed at the same conditions too.

The discharge is irradiated by a cooper laser (10 KHz, 10 ns) beam (0.6 mm, λ = 578.2 nm, 3 W). The laser beam is mechanically chopped (1KHz). The light induced change in the conductivity is detected as a

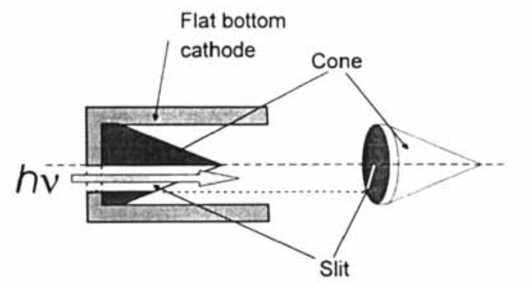

FIG.1: Conical bottom - modified hollow cathode

voltage variation ΔU across a resistor (1 MΩ) connected in series with a 10^4 pF decoupling capacitor. A lock-in nanovoltmeter type 232B ("Unipan") is used. The carrier gas Ar pressure is 1 Torr and the radial distribution $\Delta U(R)$ is measured at discharge current 40 mA.

RESULTS AND DISCUSSIONS

1. Optogalvanic effect in CBHCD

The measured radial distributions of the OG signal in both cathodes with flat and conical bottoms are presented in FIG 2. The curves suggest the improved light induced conductivity in CBHCD. In this comparison the radial dependence of the optical path $k_0 l$ CBHCD should be taken in mind, i.e. it is shorter in each R_i point in relation to the same in FBHCD. In this context the flat bottom cathode has some absorption advantage in our experimental design. The maximum OG signals are measured in the cathode dark spaces. The same is observed for FBHCD in Ref. [4]. As for CBHCD a second maximum of the OG response takes place at the minimum optical path, i.e. under the cone peak. Here each signal $\Delta U(R_i)$ is of higher amplitude, except for that at the cathode cylindrical surface. Taking in mind the above $k_o l$ peculiarities the greater

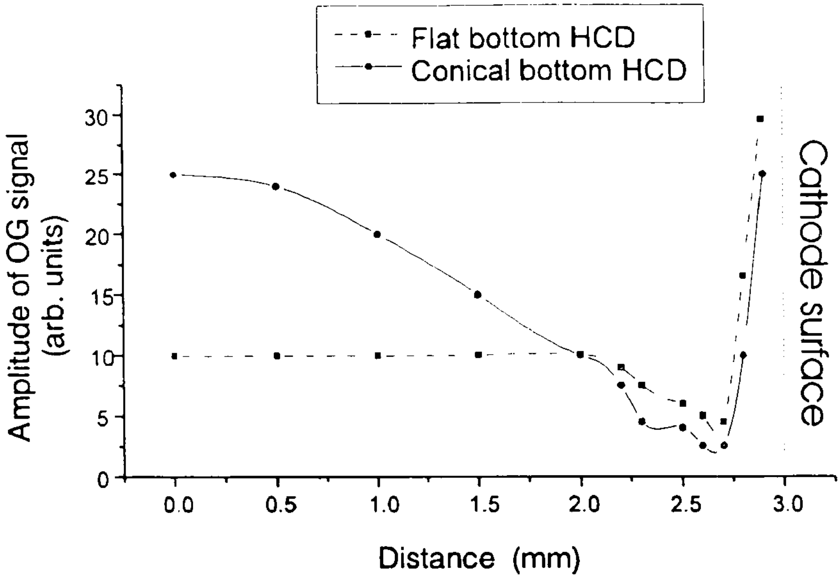

FIG. 2: Radial distribution of the optogalvanic signals in flat bottom and conical bottom HCD

OG response in the CBHCD might be connected to the higher enough sputtered atoms density [1]. Thus FIG.1 illustrates the higher OG efficiency of the CBHCD in relation to the sputtered atoms.

When the entire negative glow is illuminated, i.e. from the open cathode part, the CBHCD gives an essentially larger integral response in relation to the FBHCD. Two additional light-induced contributions might be responsible here:

i) the larger conical bottom surface results in the larger cathode dark space volume illuminated;

ii) the photoemission OG effect due to laser beam - surface interaction.

2. The OG signal of sputtered atoms and the conical surface

Earlier the spectroscopic effect of CBHCD was established without any relation to the enlargement of the cathode surface due to the cone [1].

The analysis of the conical surface after the measurements shows the strongest destruction near the conical tip. Earlier the mean energy of the bombarding argon ions at the cathode surface was calculated to be 104 eV [5]. Obviously, the tip is bombarded more intensively compared to the other surface. The more intensive electric field near the tip is the most probable reason for this local Ar^+ ion acting. These results confirm the conclusions based on the signal of the self-aligned atoms [3], i.e. the effect of the CBHCD is, first of all, due to the destruction of the tip and the enrichment of the plasma by sputtered cathode material. The metal compositions of the couple "cylinder-cone" is also of importance for this process [2].

CONCLUSIONS

1. The conical bottom increases the integral OG signal in HCD forming a second OG peak.

2. The additional peak is located near the cone tip and is of the order of that in the cathode dark space.

3. The destruction of the cone tip enriches the CBHCD with sputtered atoms.

4. The CBHCD manifests itself as a perspective detector of OG signals from sputtered atoms.

ACKNOWLEDGEMENTS

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