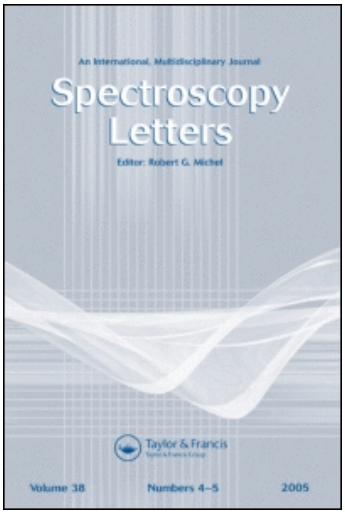

Spectroscopy Letters
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713597299

Penning Interaction Ne-As and Optogalvanic Signal Deformation

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To cite this Article Zhechev, D. Z.(1992) 'Penning Interaction Ne-As and Optogalvanic Signal Deformation', Spectroscopy Letters, 25: 4, 507 — 511
To link to this Article: DOI: 10.1080/00387019208021525
URL: http://dx.doi.org/10.1080/00387019208021525

SPECTROSCOPY LETTERS, 25(4), 507-511 (1992)

PENNING INTERACTION Ne-As AND OPTOGALVANIC SIGNAL DEFORMATION

Key Words: Optogalvanic Effect, Hollow Cathode Discharge, Penning Interaction

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ABSTRACT

The optogalvanic response of Ne-As hollow cathode discharge plasma is found to be deformed depending on the discharge current.Penning Ne-As interaction is supposed and spectroscopically confirmed.

INTRODUCTION

The use of Hollow Cathode Discharge (HCD) as Optogalvanic (OG) detector stimulates further investigations on the effect of resonant light on plasma conductivity.Here a deformation of the real OG signal in HCD is reported.

EXPERIMENT

A Ne/As HCD spectral lamp ("Pye Unicam") is irradiated by He-Ne laser (632.8nm, 1.15μm and 3.39μm).In addition as an illuminating source a filament lamp with

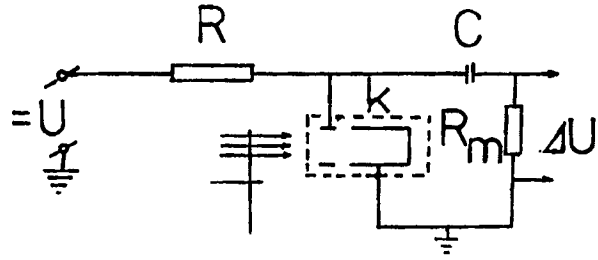

Fig.1. Schematic setup

a high resolution monochromator is used.In this way some $1s_i$-$2p_j$ transitions of neon atom are influenced.A standard OG scheme (Fig.1) detects the change ΔU of the cathode voltage drop U.

RESULTS AND DISCUSSIONS

The OG signals ΔU v.s. discharge current i_d are detected.In the vicinity of i_d=6mA identical signals (Fig.2) for the three laser lines are observed.The form and i_d localization of the peaks in Fig.2 are found to be independent on the incident light frequency.This fact gives rise to doubt about the OG nature of response $\Delta U(i_d)$ near i_d=6 mA.The following irradiation by spectral lines of $1s_i$-$2p_j$ transitions (640.2 nm, 594.5 nm, 540.0 nm, 607.4 nm, 626.6 nm, 585.2 nm) confirms the nonoptogalvanic character of the Ne-As plasma reaction at i_d= 6mA.The same peak is detected when the lamp is illuminated by the full or partial frequency emission of a Ne/Al lamp.One should note that the metastable $^3P_2$ neon level irradiated as a low one forms at $i_d \neq$ 6mA a real OG signal opposite in sign to the other ones from $1s_i$-$2p_j$ transitions and

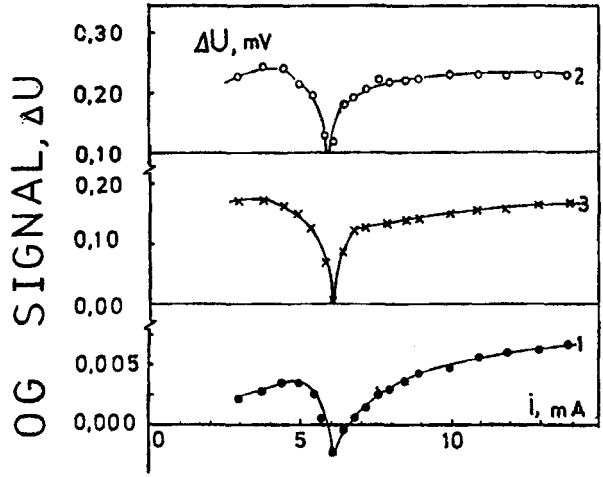

Fig.2. Optogalvanic response of Ne/As lamp("Pye Unicam"): 1- 632.8 nm; 2- 1.15 μm; 3- 3.39 μm.

this sign is specific for the metastable level irradiated.

Thus the reason for this light frequency nonselectivity should be a more general one and should be looked for as a bulk Ne-As plasma effect. The closeness between the metastable $Ne^m(^3P_2)$ and $AsII(^5S_2)$ levels[1] (Fig.3) is the reason for a Penning process:

/1/

$$Ne^m(^3P_2) + As(^4S_{3/2}) \longrightarrow Ne(^1S_0) + AsII(^5S_2) + \Delta E + \vec{e}$$

increasing the plasma conductivity. A spectral proof for the process /1/ could be the behaviour of the relevant line intensities. Fig.4 shows the AsII 191.29 nm ($^3P_2 - {}^5S_2$) and AsI 193.7 nm ($^4S^o_{3/2} - {}^2D^o_{3/2}$) spectral line intensities I_α and I_β respectively as

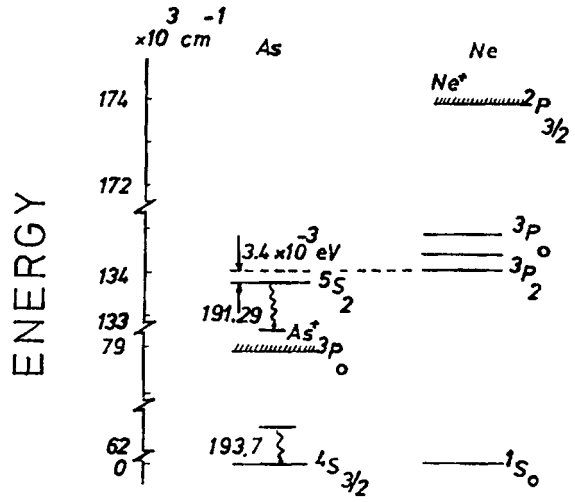

Fig.3. Diagram of the interacting Ne, As and As^+ levels.

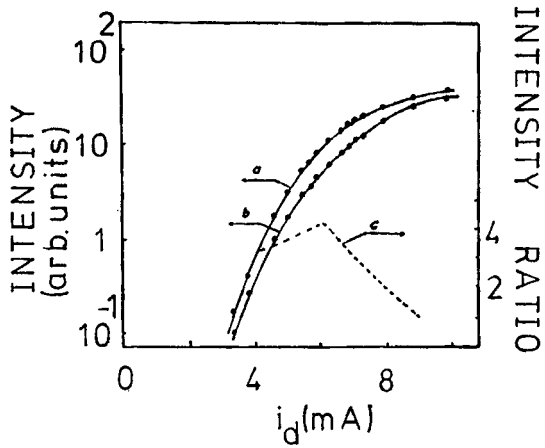

Fig.4. Intensity of AsII 191.29 nm (a) and AsI 193.7 nm (b) spectral lines v.s. discharge current in Ne/As lamp ("Pye Unicam"); c - ratio of the intensities.

well as their ratio I_a / I_b .The upper level of AsII 191.29 nm is populated additionally by the pro - cess /1/ creating As^+ ions of $4s4p^3{}^5S_2$ state. The other line intensity I_b is not connected with the aforementioned process directly.Then the ratio I_a / I_b should be sensitive to any selective change of $AsII\ ^5S_2$ level population.Indeed, curve c (Fig.4) illustrates a peak of the ratio at i_d=6mA where the Penning process takes place.The correlation between $\Delta U(i_d)$ and $I_a / I_b = \varphi(i_d)$ near 6 mA is an indication that both are based on process /1/ and also that the peaks can not be identified with the real OG effect according to Ref.2,3.

CONCLUSION

The observed galvanic effect of Ne-As HCD plasma deforms the real optogalvanic response and limits its analytical possibilities.We have detected such a deformation of the time depending OG effect too and its appearence will be analyzed.

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Date Received: 12/03/91
Date Accepted: 01/07/92