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## **Penning Interaction Ne-As and Optogalvanic Signal Deformation**

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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, 1.15  $\mu$ m and 3.39  $\mu$ m). In addition as an illuminating source a filament lamp with

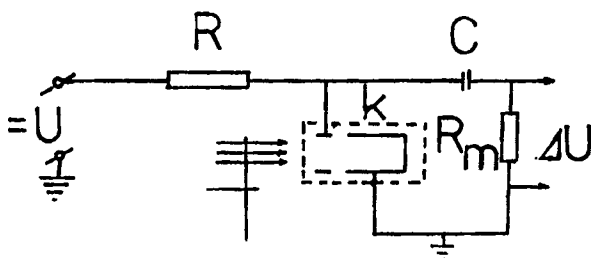


Fig.1. Schematic setup

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  $\Delta U$  of the cathode voltage drop  $U$ .

### RESULTS AND DISCUSSIONS

The OG signals  $\Delta U$  v.s. discharge current  $i_d$  are detected. In the vicinity of  $i_d=6\text{mA}$  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  $i_d=6\text{mA}$ . 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  $i_d=6\text{mA}$ . 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  $i_d \neq 6\text{mA}$  a real OG signal opposite in sign to the other ones from  $1s_i-2p_j$  transitions and

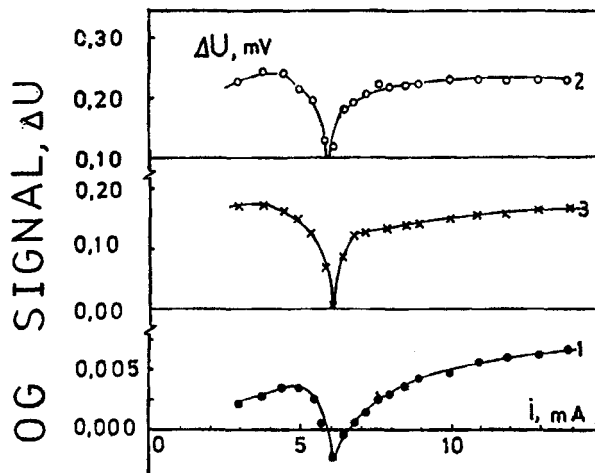
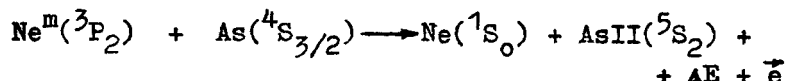


Fig.2. Optogalvanic response of Ne/As lamp("Pye Unicam"):  
1- 632.8 nm; 2- 1.15  $\mu\text{m}$ ; 3- 3.39  $\mu\text{m}$ .

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  $\text{Ne}^{\text{m}}(^3\text{P}_2)$  and  $\text{AsII}(^5\text{S}_2)$  levels<sup>1</sup> (Fig.3) is the reason for a Penning process:

/1/



increasing the plasma conductivity. A spectral proof for the process /1/ could be the behaviour of the relevant line intensities. Fig.4 shows the  $\text{AsII} 191.29 \text{ nm } (^3\text{P}_2 - ^5\text{S}_2)$  and  $\text{AsI } 193.7 \text{ nm } (^4\text{S}_{3/2}^{\circ} - ^2\text{D}_{3/2}^{\circ})$  spectral line intensities  $I_{\alpha}$  and  $I_{\beta}$  respectively as

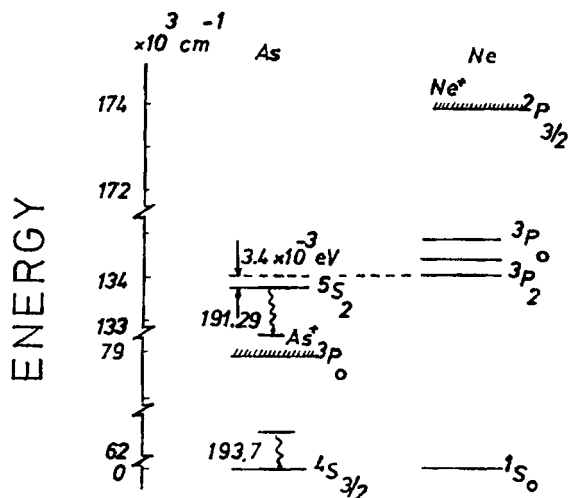


Fig.3. Diagram of the interacting Ne, As and  $\text{As}^+$  levels.

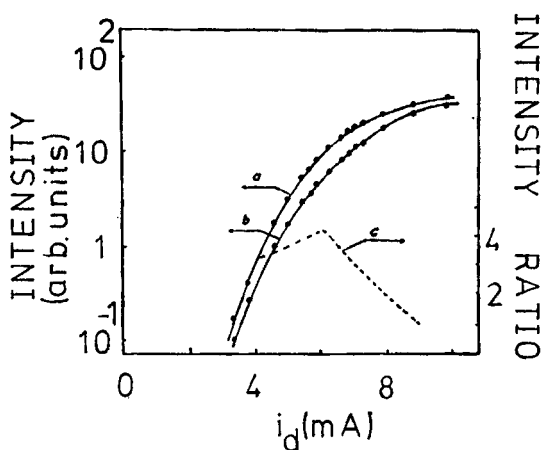


Fig.4. Intensity of AsII 191.29 nm (a) and AsI 193.7 nm (b) spectral lines v.s. discharge current in Ne/As lamp ("Pye Unicam"); c - ratio of the intensities.

well as their ratio  $I_a / I_\ell$ . The upper level of AsII 191.29 nm is populated additionally by the process /1/ creating  $As^+$  ions of  $4s4p^3^5S_2$  state. The other line intensity  $I_\ell$  is not connected with the aforementioned process directly. Then the ratio  $I_a / I_\ell$  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  $i_d = 6\text{mA}$  where the Penning process takes place. The correlation between  $\Delta U(i_d)$  and  $I_a / I_\ell = \varphi(i_d)$  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 appearance will be analyzed.

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