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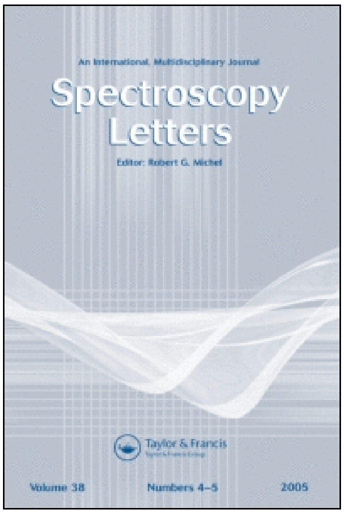

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Sputtering of the Magnesium Cathode Surface by Ar Ion

D. Z. Zhechev[a]
[a] Institute of Solid State Physics, Sofia, Bulgaria

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SPUTTERING OF THE MAGNESIUM CATHODE SURFACE BY Ar^+ ION

Key words: Hollow cathode discharge, Sputtering coefficient, Dark cathode space

D.Z.Zhechev

Institute of Solid State Physics, BAS
72 Tzarigradsko Chaussee blvd.
1784 Sofia, Bulgaria

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ABSTRACT

The sputtering of magnesium cathode surface by argon ions is analysed. The real sputtering coefficient in the discharge S_R=0.03 atoms/ion is calculated for the parameters of the used hollow cathode discharge.

INTRODUCTION

When the spectrum of a material which is difficult to sputter presents an interest, argon is particularly suitable as a working gas in Hollow Cathode Discharge (HCD). Magnesium is precisely this type of material and its spectrum is usually excited in HCD. There are very few data on magnesium surface

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sputtering at all. That is why in this report the parameters of this process are calculated for Ar/Mg couple HCD. The yield of Mg atoms is also evaluated.

EXPERIMENT AND CALCULATIONS

A cylindrical bottomless cathode (2R=8mm, l=40mm) from magnesium is used The discharge. operates at argon pressure p_{Ar}=0.3Torr and discharge currents from 5mA to 40mA. Within this $\{p_{Ar}, i\}$ range the spectrum of Mg atoms is observed to be stable enough.

1. Determination of the Sputtering Coefficient S

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The interaction between the cathode surface and the bombarding argon ion depends on the energy of Ar^+ particle, accelerated during its last free path λ_i in the cathode dark space. Taking into account that the resonant recharge process $Ar + Ar^+ \rightleftarrows Ar^+ + Ar$ is the main one in the dark space[1], the λ_i-value is determined by the corresponding cross-sections $Q_r(v)$ and the concentration of Ar^+ ions n: $\lambda_i = (n \cdot Q_r(v))^{-1}$. The energy $W = Mv^2/2$, accumulated near the cathode surface is calculated by the equation:

$$eE = eU/d = p_{Ar} \cdot Q_r(v) \cdot Mv^2/2 \quad (1)$$

where E is the electric field intensity in the dark space, U - the cathode voltage drop, d - the width of the dark space and M the mass of Ar^+ ion.

Eq. (1) is solved graphically by using $Q_r(v)$ data in Ref. [2]. The values $v = 1.6 \cdot 10^6 cm.s^{-1}$ and $Q_r(v) = 32.5 \cdot 10^{-16} cm^2$ are found to satisfy the equation when p_{Ar}=0.3Torr, U=260V, d=0.15cm, i=10mA. The maximum energy W_m of Ar^+ bombarding ion corresponds to the maximum intensity of the field E_{max}. From the relation E_{max}=2U/d and Eq. (1) the maximum energy is calculated to be W_m=104eV.

For the Ar/Mg couple there are no data for the sputtering coefficient S at W=104eV up to date. By extrapolating the data in Ref. [3] the value S(W=104eV)=0.1 atoms/ion is found.

The real coefficient S_R in the discharge is calculated based on the consideration in Ref. [4], i.e. by introducing an imaginary source of Mg atoms near the cathode surface. Then, according to Ref. [5] the value $S_R=0.03$ atoms/ion is obtained taking into account both the localisation of the imaginary source near the surface (calculated distance about 0.07 cm) and $p_{Ar}=0.3$Torr.

2. Yield of the Sputtered Mg Atoms in Ar/Mg HCD

The number N of Mg atoms appearing per unit length l of the imaginary source in s^{-1} can be found from the relation:

$$N = i \cdot S_R (e \cdot l)^{-1} \text{ atoms}$$

The value $N = 1.1 \cdot 10^{15}$ atoms/cm.s is calculated at above mentioned parameters of the discharge.

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