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SPECTRA OF THE GRIMM TYPE GLOW DISCHARGE IN THE VICINITY OF HYDROGEN L_α LINE

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ABSTRACT. We report in this paper prelimary investigations of the hydrogen spectra of the Grimm type glow discharge in VUV region. The influence of the cathode material to the intensity of L_α line is determined.

1. INTRODUCTION

The glow discharge source between a flat cathode and a hollow anode was described by Grimm (Grimm, 1968) and studied for the last few years in our laboratory (Kuraica et al. 1991, Kuraica et al. 1997). This is well-established excitation source for analysis of the composition of conducting solid samples by atomic emission and absorption spectroscopy. The cathode material is atomized and excited through the processes of intense sputtering which influences considerably elementary processes in glow discharge plasma. Here we report measurements of the influence of the cathode material to the intensity of the L_α line.

2. EXPERIMENTAL SETUP

The discharge source was modified Grimm GDS constructed in our laboratory following the design of Ferreira (Ferreira et al. 1980). It was described in detail elsewhere (Kuraica et al. 1991), so minimum details were be given here for completeness. In order to perform VUV spectroscopy the length of the discharge chamber was decreased in comparison with our previous design (Kuraica et al. 1991). The cylindrical brass chamber 110 mm long and 40mm in diameter has a flange on the bottom so that discharge can be directly mounted on monochromator slit and observed end-on. The hollow anode was 30 mm long with inner and outside diameter of 8 and 13 mm. Onto the water-cooled hollow holder of the cathode, the exchangeable copper or iron electrode 5 mm long and 7.6 mm in diameter can be tightly screwed to ensure good cooling. The cathode is mounted inside hollow anode. The discharge chamber is evacuated in the typical way for the Grimm discharge and in addition trough the slit of the vacuum spectrometer. With two stages mechanical pump the whole system was evacuated to one Pascal. In order to prevent back streaming of oil vapours, the zeolite trap is mounted on vacuum pump. The gas flow is controlled by needle valve and gas pressure was measured by mechanical and Pirani gauge. To run the discharge, a 0 - 2 kV and 0 – 100 mA current stabilized power supply was used. A ballast resistor of 10 kΩ is placed in series with the discharge and power supply.

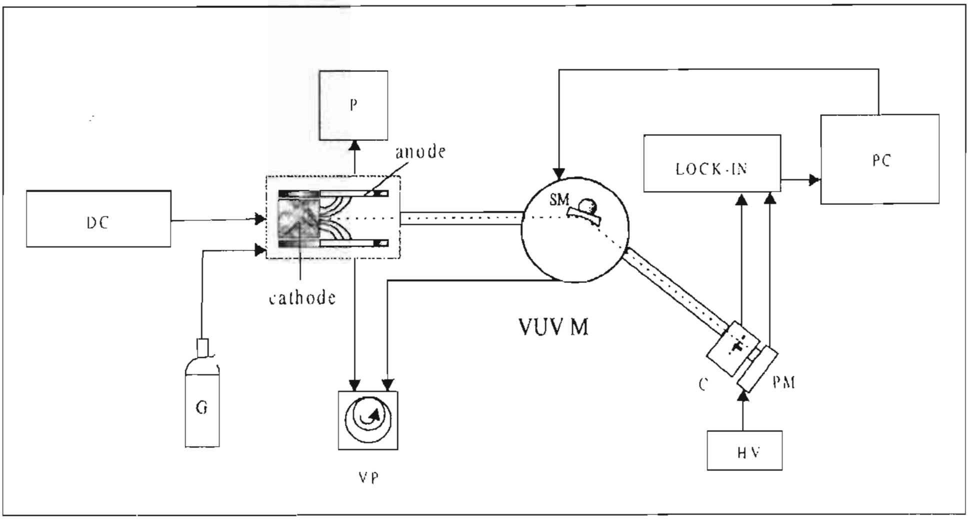

Fig.1. Experimental setup. DC – power supply, P – pressure measurement, VUV M – vacuum uv monochtomator, SM – step motor, VP – vacuum pump, C – chopper, PM – photomultiplier, HV – high voltage power supply for PM.

The radiation from the discharge source is spectrally analysed by Seya-Namioka monochromator (JOBIN-YVON LHT 30) with toroidal reflection grating (horizontal and vertical radius of curvature 1000 mm and 103 mm, respectively, 275 grooves mm^{-1}, inverse dispersion 2 nm/mm); 0.1 mm entrance and exit slits were used. Monochromator is equipped with a stepping motor, which enables a minimum wavelength change in steps of 0.01 nm. The radiation detection system consists of the glass window covered with the layer of sodium salicylate, which converts ultraviolet radiation into visible light. The radiation is then chopped at a frequency of 372 Hz (SR 540 Stanford Research System variable frequency chopper unit) and focused on photomultiplier HAMAMATSU R212. The signals from photomultiplier were amplified and digitalized by an SR 510 lock-in amplifier (Stanford Research System) and transferred to a PC that also controls step motor.

3. RESULTS AND DISCUSION

The spectra in the range of 80 to 170 nm are observed in the discharge in pure hydrogen. The Lyman – alpha line dominates the spectrum, but the largest portion of the spectra is covered by band structure of molecular hydrogen, see Fig.2. (At 167 nm H_2 continuum starts). Spectrum intensity dependence upon pressure is observed for Cu and Fe cathode. In both cases it is noted that band spectra increase as the pressure increases while the atomic line is not so much pressure dependent, see Fig.2 and Fig.3.

The comparison of spectra obtained with Cu and Fe cathode under the same discharge conditions (same power and pressure) shows that L_α is more intense with Cu cathode while the H_2 molecular band remained with the same intensity, see Fig.4.

By measuring the whole spectrum with Cu cathode for different power input it was determined that L_α intensity increases with power while the molecular band spectra do not change noticeably. In case of Fe cathode both L_α and the band spectrum intensities are increased as power increases.

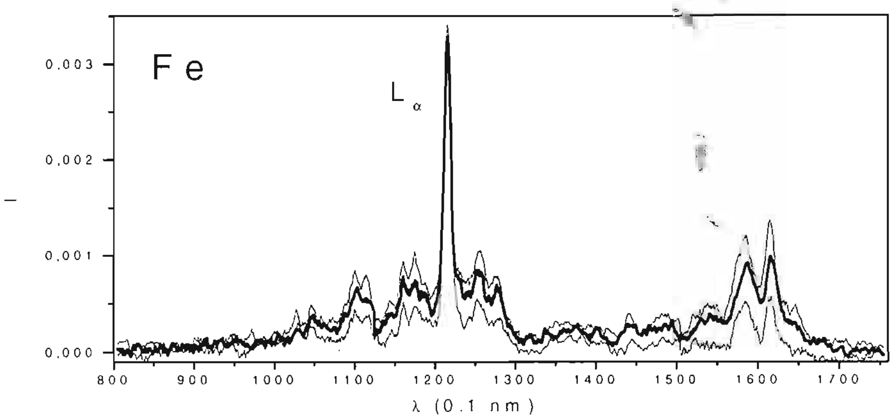

Fig.2. Pressure dependence for Fe cathode; power input 17.5 W, pressures: 2700, 3400, 3900 Pa.

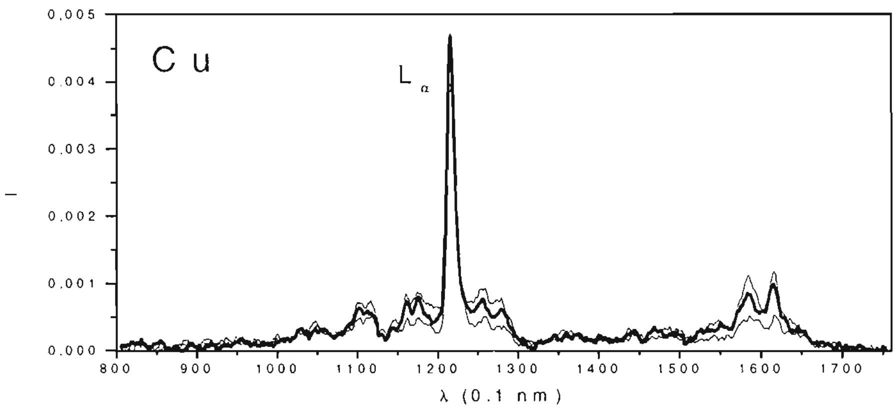

Fig.3. Pressure dependence for Cu cathode; power input 17.5 W, pressures 2700, 3400, 3900 Pa

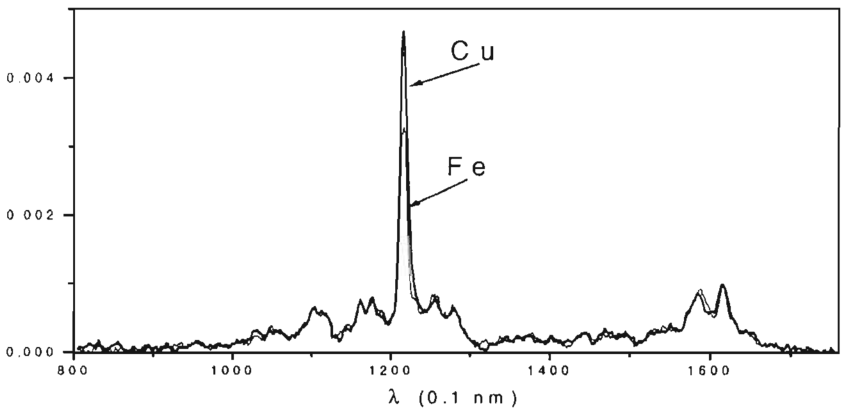

Fig.4. Spectra with Cu and Fe cathode under the same conditions p=3400 Pa, P=17.5W

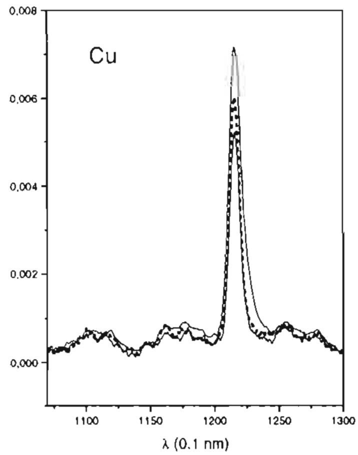

Fig.5. Intensity dependence versus power input for Cu cathode p=3400Pa; P=8.9; 15.9 and 28.6 W

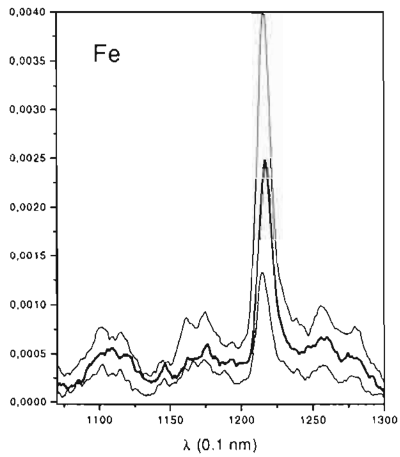

Fig.6. Intensity dependence versus power input for Fe cathode p=3400Pa; P=6.7; 14.6 and 28.6 W

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