

EUV EMISSION SPECTRA FROM EXCITED Ar, Xe AND Sn IONS
PRODUCED IN CAPILLARY DISCHARGES

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This work presents preliminary results of an extreme ultraviolet emission observations of a capillary discharge plasma. The main purpose of measurements was to demonstrate the spectral range covered by the system working parameters. The spectroscopic studies were carried out by means of an XEUV spectrometer in the Johann geometry. The results provide general information about the radiation processes from the xenon, argon and tin plasma in the range from 12 to 63 nm.

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INTRODUCTION

Gas discharges in capillary are the promising candidates for generation of EUV radiation and thus are quite often studied by various experimental techniques [1-8]. There are studied as intense soft X-ray sources and a cheap alternative to laser-plasma, free-electron, synchrotron sources, as well as sources based on higher harmonics generation. These sources are of potential interest in a wide field of applications such as lithography, holography, characterization of material and microscopy [9,10]

The capillary construction is a very simple but it creates a sophisticated multiparametric system. The device consists of a non-conductive duct placed between two electrodes which are connected to a bank of low-inductance high voltage (HV) capacitors charged to several of kV. Driver characteristics (current amplitude, current rise-time), initial conditions (gas pressure, pre-pulse capillary current) and boundary conditions (length and diameter, material of capillary and electrodes) are important for achieving an efficient population in gas discharges. It is desirable to find optimal conditions, especially initial conditions of the discharge, to get from the device coherent EUV radiation with good repeatability [11].

In this paper we made a first step in observations of extreme ultraviolet emission from capillary discharges. Mainly we studied the spectral range over which the system was capable to work and provide general information about the radiative processes in the plasma generated in our capillary device.

EXPERIMENT

A cross sectional view of the capillary discharge experimental setup used for generating the EUV radiation is shown in Fig.1. The discharge setup consists of a brass electrode and an alumina capillary of 1,5 mm inner diameter and 8-mm length.

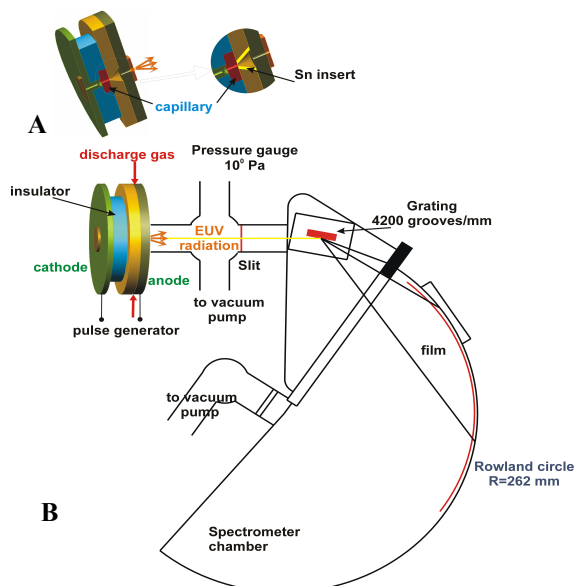


Fig. 1. The experimental setup for the capillary discharge measurements. A - the capillary discharge device, B - the spectrometer

The capillary was mounted between two specially designed electrodes with the help of an electrically insulating holder, in such a manner that the two ends of capillary had good contact with electrodes. The discharge voltage of the condenser battery of 0,375 μ F was equal to 8 kV ($I \sim 3,5$ kA achieved in about 1 μ s). The capillary was evacuated below 10^{-5} mbar using a turbo-molecular pump (Pfeiffer TC100). The processes were conducted with two kinds of the filling gas: pure xenon or argon. The working gas flows through the capillary and was differentially pumped out from the system. The gas pressure near the electrodes was controlled up to tens of Pa. Number of single discharges was equal to one thousand. In case of Sn ions registration a tin insert was mounted in the brass anode (see Fig.1).

The spectroscopic studies were carried out by means of the XEUV spectrometer in the Johann geometry. The

means of the XEUV spectrometer. The spectrums were registered in the 12 - 64 nm, 12- 61 nm and 15- 55 nm wavelength ranges for Xe, Ar, and Sn + Ar ions, respectively. Additionally we learned that the brass electrode and alumina capillary ablates and therefore a problem of debris generation exists.

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ВУФ- ЭМИССИОННЫЕ СПЕКТРЫ ВОЗБУЖДЕННЫХ Ar, Xe И Sn ИОНОВ, ПРОИЗВЕДЕННЫХ В КАПИЛЛЯРНОМ РАЗРЯДЕ

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Представлены первые результаты наблюдения эмиссии вакуумного ультрафиолетового (ВУФ) излучения в плазме капиллярного разряда. Основной целью измерений являлась демонстрация покрытия спектрального диапазона рабочими параметрами системы. Спектроскопические исследования проведены с помощью ВУФ спектрометра Джоханновской геометрии. Результаты дают общую информацию о процессах излучения из ксеноновой, аргоновой и свинцовой плазмы в диапазоне от 12 до 63 нм.

ВУФ- ЕМІСІЙНІ СПЕКТРИ ЗБУДЖЕНИХ Ar, Xe И Sn ІОНІВ, ЗРОБЛЕНИХ У КАПІЛЯРНОМУ РОЗРЯДІ

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Представлено перші результати спостереження емісії вакуумного ультрафіолетового (ВУФ) випромінювання в плазмі капілярного розряду. Основною метою вимірів була демонстрація покриття спектрального діапазону робочими параметрами системи. Спектроскопічні дослідження проведені за допомогою ВУФ спектрометра Джоханнівської геометрії. Результати подають загальну інформацію про процеси випромінювання з ксенонової, аргонової і свинцевої плазми в діапазоні від 12 до 63 нм.