FORMATION OF SELF-FOCUSED ION BEAM

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Abstract

•**The formation of self-focused ion beam with a small diameter is proposed. The device for the formation of self-focused ion beam consists of a hollow anode and enveloped cathode, separated from the anode by an insulator, gas delivery system. A discharge is supported by the high voltage applied between the cathode and anode. The ion beam is self-focused by the spherical emission surface of emitting plasma.**

•**The result of computer simulation of self-focused ion beam production is presented. The device for self-focused ion beam production is described.**

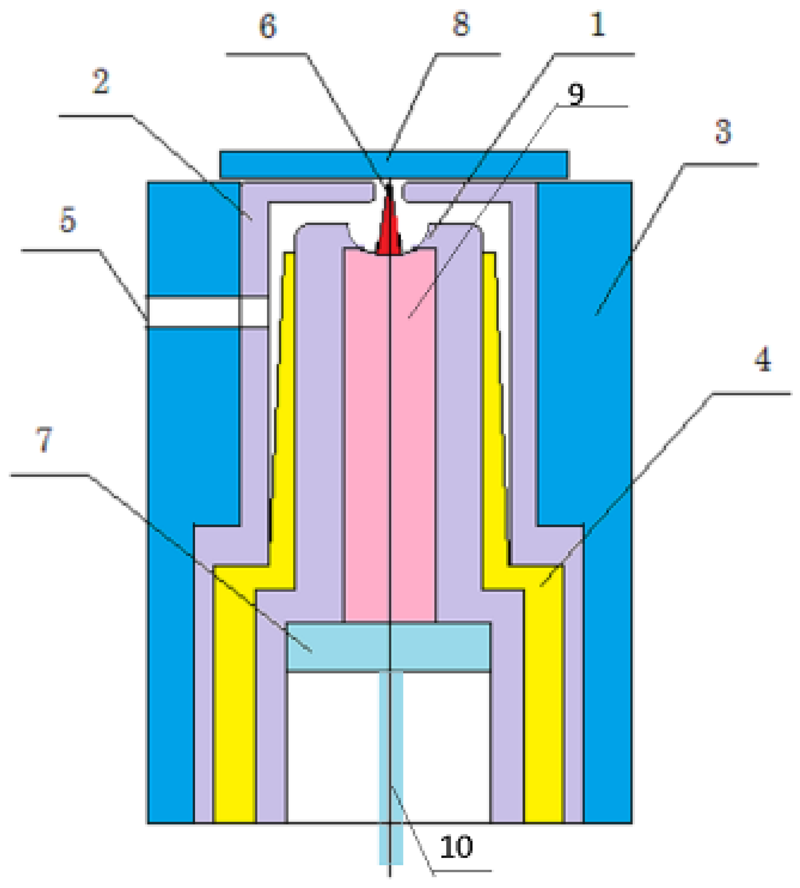

Fig. 1 The scheme of the discharge device with self-focusing ion beam. 1-anode; 2-cathode; 3- base; 4-insulator; 5-gas supply; 6-focused ion beam; 7-window; 8-sample, 9-discharge plasma, 10-fiberglass optic.

INTRODUCTION

Sputtering occurs when particles of a solid material are ejected from its surface by energetic particles from a plasma. A small change in the design of the plasma discharge device makes it possible to localize sputtering on a small portion of the target and to obtain the distribution of ejected elements over the surface of the sample with micron resolution. Another change, to be developed in this project, will be to generate a line of plasma that will allow rapid scans of 1 square cm area samples.

For surface analysis, optical glow discharge spectroscopy (OGDS) is used []. Ions from the plasma discharge sputter the atoms from the surface and the electrons from the plasma discharge excite and ionize the sputtered atoms. OGDS uses the light emitted by the excited particles for quantitative analysis
The Grimm discharge lamp is typically used for OGDS. The radiation of sputtered atoms is recorded by a spectrometer through a window and fiberglass cable. The anode is separated from the cathode by an insulator. The anode has an inner diameter of 7-10 mm. It is covered by a diaphragm with a 3 mm diameter hole. The anode-cathode gap is set to within 0.25-2.5 mm. Helium, Neon, Argon, Krypton and/or Xenon gases are fed into the cathode-anode gap through a leakage channel with gas pressure of about ~1-5 Torr. A high voltage of 1 to 2.5 kV is applied to the anode. Light is recorded along the axis of the device through window and fiber optic cable. The emitted spectrum can be recorded by an inexpensive Ocean Optic spectrometer with a fiberglass light gate.

PROPOSED ANALYZER WITH SELF-FOCUSED ION BEAM

The scheme of the proposed device is shown in Fig. 1. In the device shown in Fig. 1, the ion flux 6, extracted from the gas-discharge plasma 9, is focused by a spherical emission surface to micron sizes on sample 8, providing very local sputtering and local elemental analysis. The radiation of sputtered atoms is recorded by a spectrometer through window 7 and fiberglass cable 10. The anode is separated from the cathode by an insulator 4.

The anode 1 has an inner diameter of 7-10 mm. It is covered by a diaphragm with a 3 mm hole. The distance between the anode 1 and cathode 2 is set within 0.25-2.5 mm. Helium, neon, argon, krypton, and/or xenon gases are fed into the cathode-anode gap through the leakage channel 5. The gas pressure is ~1-5 Torr. Better special resolution can be obtained with He gas. A high voltage of 5kV to 7 kV is applied to the anode. Light is recorded along the axis of the device through window 7 and fiber optic cable 10.

To register the distribution of elements over the sample, the sample is scanned mechanically. An analysis of dielectric samples is possible. The emitted spectrum will be recorded by an Ocean Optic spectrometer with a fiberglass light gate. Related software will be used for spectrum identification. Rapid scanning can be produced with low resolution ~1 mm. A chosen area can be scanned with high resolution ~1 micron. Ions produced in the plasma from sputtered atoms can be extracted and analyzed by a mass spectrometer.

(The author VD has used a similar simple device with discharge in residual air to drill micron-sized holes in metallic foils.)

Fig. 2 shows a computer simulation of fine-focused ion beam formation by code IBSimu.

He+ ion current Ie=1 mA, extraction voltage Ue=7 kV.

Current density distribution (up to 1.5 A/cm2).

The simulation was conducted without space charge neutralization. But the coefficient of secondary ion/electron emission could be ~4. This can produce a space charge neutralization and future decrease a transverse ion beam size

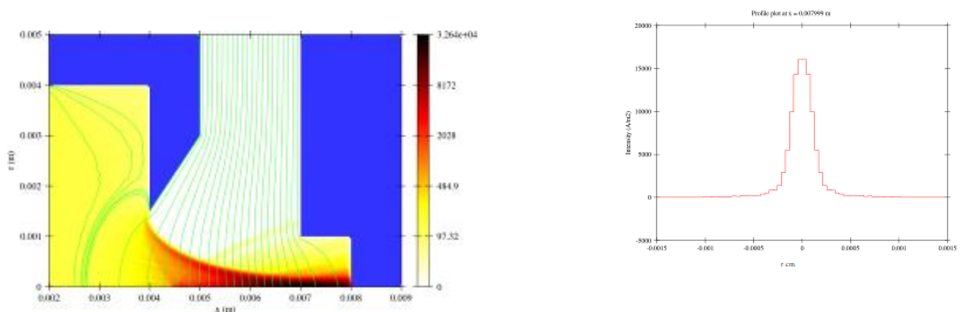

Fig. 2. Computer simulation self-focused Ion beam extraction from gas discharge plasma by computer code. Emission aperture d=3 mm, extraction gap h=4 mm.

Fig. 3. Pumping system for self-focused ion beam, production

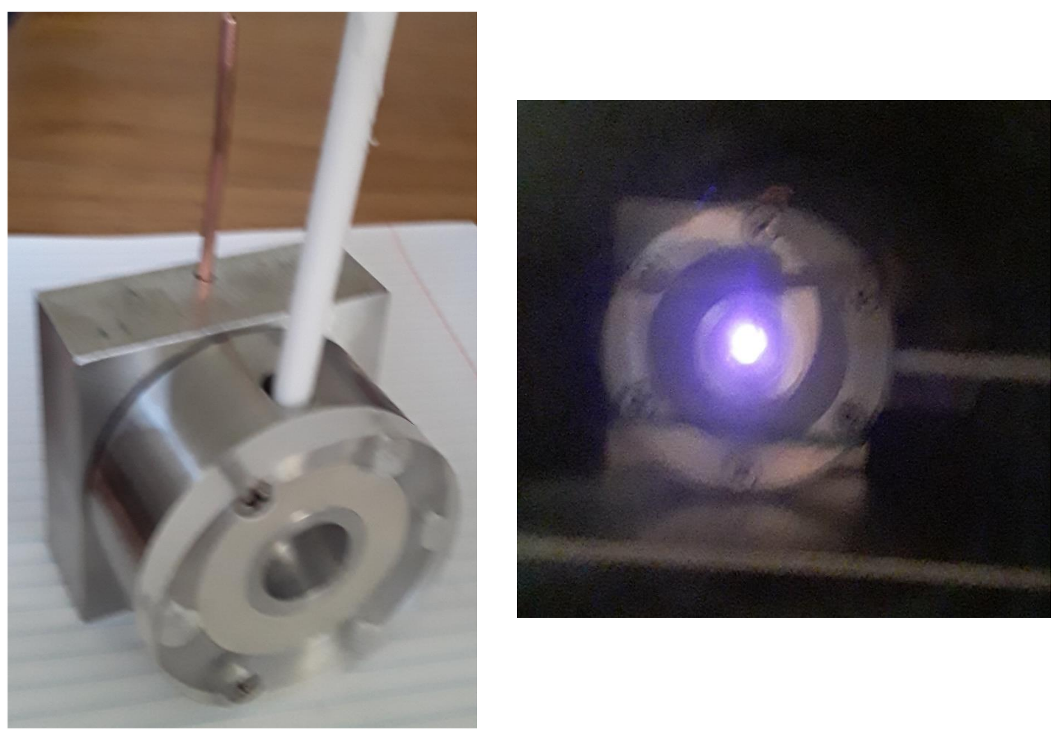

Fig. 4 Photograph of the device for production of selffocused ion beam and high voltage discharge with selffocused ion beam formation

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