сообщения
объединенного
института
ядерных
исследований
дубна

E13-85-666

R.Taraszkiewicz

SIMPLE HIGH-STABILITY METALLIC PLASMA SOURCE

1985

1. INTRODUCTION

In electrospark plasma source stability of the plasma parameters is permanently decreasing during operation[1], so that their service life is usually limited to $10^5 \div 10^6$ shots. This fact is connected with deepening of erosion craters on the electrodes surfaces which results in alteration of electric discharge conditions. With the aim of increasing source stability and service life an electrospark plasma source with a slowly moving cathode has been elaborated at the Department of New Acceleration Methods. In this source the active area of the cathode surface is incessantly renewed permitting to prolong the service life up to $10^7 - 10^8$ shots with high stability of the produced plasma parameters. Having composed the cathode of several conducting solid elements allows to change the components of the plasma flow rapidly.

2. THE SOURCE DESCRIPTION

Generally, the source[2] represents a two electrode vacuum gap with one of the electrodes being of cylindric form and moving inside a ceramic tube. The tube has an aperture (discharge canal) of 1,5 mm in diameter. The second electrode is placed on

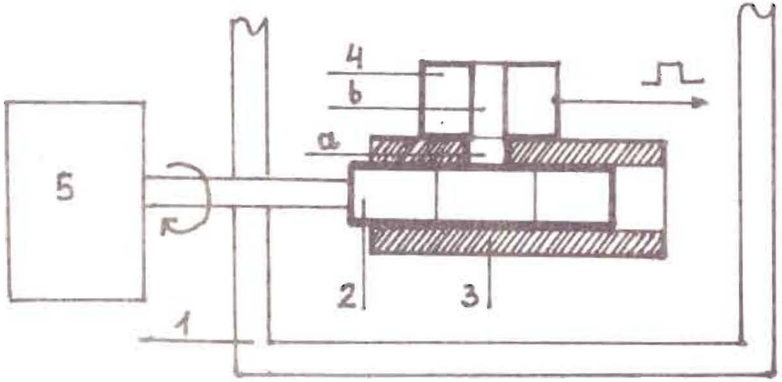

Fig.1

the tube outer surface and has an orifice coaxial with the discharge canal. The inner electrode can move along the tube axis and, at the same time, rotate around this axis.

The source is schematically shown in Fig.1. Here 1 is a vacuum chamber, 2 is the central (moving) cylindrical electrode; 3, the ceramic tube with discharge canal "a"; 4, the outher electrode with orifice "b"; 5 is the central electrode driving engine. A square unipolar voltage pulse of amplitude U = = 10 ÷ 15 kV and duration $t = 2 \cdot 10^{-6}$s is applied to the gap. The discharge current varies in range of 800 A to 1200 A. The inner electrode, acting as a cathode, is subjected to electroerosion. The source can operate either in single pulse or cyclic mode at reprate up to 10 Hz. The operating vacuum in the chamber is $4 \div 6 \cdot 10^{-6}$ Torr.

3. EXPERIMENTAL RESULTS

Plasma jets emitting into vacuum from either metallic (Al, Cu, Pb) or graphite elements of the cathode have been investigated. The total number of particles (atoms and ions) in the flow was determinated by the deposition method. The observed deposit layers structure is homogeneous and includes neither droplets nor fragments of the electrodes materials. At chosen sourse operating mode ($t = 2\mu s$, $J = 1200$ A, $\nu = 2$ Hz) the total number of deposited particles was found to be about $2.6 \cdot 10^{17}$ for copper cathode and about $8.0 \cdot 10^{17}$ for graphite cathode after $8 \cdot 10^4$ shots. Neglecting

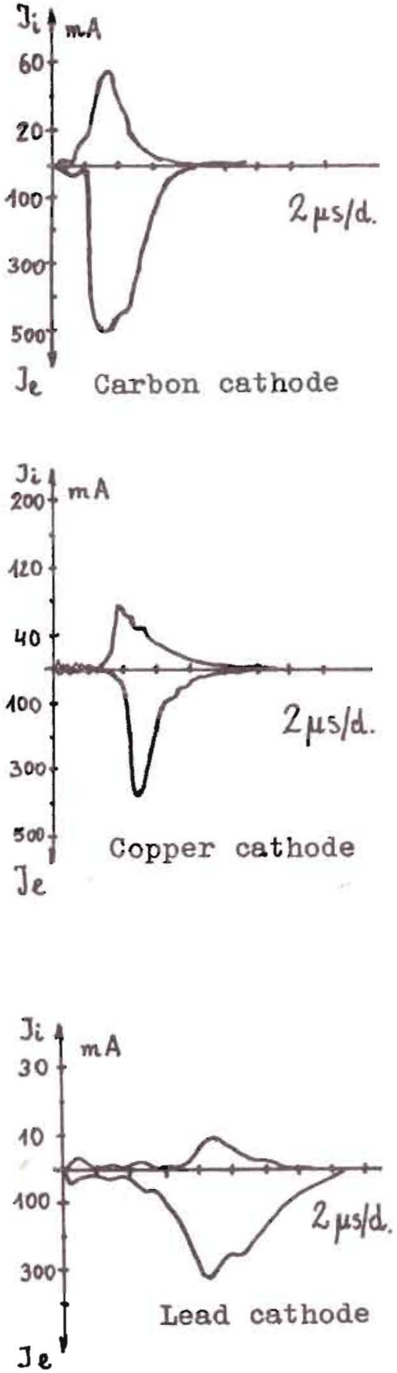

Fig.2.

reflection and sputtering of deposited particles this corresponds to about $1 \cdot 10^{13}$ carbon and $3 \cdot 10^{12}$ copper atoms per pulse. The ion fraction was measured by means of Langmuir and multigrid probes.

The typical electron and ion current patterns measured with the grid probe for C, Cu, and Pb cathods are presented in Fig.2. The distance from outlet to the detector was 75 mm.

The percentage of the jet ion component was studied in a manner like in [3] and was found to be about 39% and 27% for copper and graphite correspondingly. The angles of the plasma flow divergence of about 15°-18° in the case of copper and about 80° for graphite were observed. The average particle velocities at the stream axis are $(2 \pm 0.3) \cdot 10^6$ cm/s for graphite, $(1 \pm 0.2) \cdot 10^6$ cm/s for copper and $(0.9 \pm 0.2) \cdot 10^6$ cm/s for leads.

The investigation of the plasma flow parameters shows the decrease in the flow density and average velocity and the increase in velocity dispersion with the discharge power decreasing.

REFERENCES

1. Plyutto A.A. et al. Atomnaja energija, 1957, vol.3, p.153.
2. Novikov V.G., Taraszkiewicz R. JINR, P7-84-621, Dubna, 1984.
3. Malik N.K. et al. In: Proc.of the XI Int.Symp.on Discharges and Electrical Insulation in Vacuum, Berlin, 1984, vol.I, p.147.

Received by Publishing Department
on September 11, 1985.

SUBJECT CATEGORIES OF THE JINR PUBLICATIONS

Index	Subject
1.	High energy experimental physics
2.	High energy theoretical physics
3.	Low energy experimental physics
4.	Low energy theoretical physics
5.	Mathematics
6.	Nuclear spectroscopy and radiochemistry
7.	Heavy ion physics
8.	Cryogenics
9.	Accelerators
10.	Automatization of data processing
11.	Computing mathematics and technique
12.	Chemistry
13.	Experimental techniques and methods
14.	Solid state physics. Liquids
15.	Experimental physics of nuclear reactions at low energies
16.	Health physics. Shieldings
17.	Theory of condenced matter
18.	Applied researches
19.	Biophysics

Тарашкевич Р. E13-85-666
Простой источник металлической плазмы
с высокой стабильностью

Приводятся данные исследования электроразрядного источника плазмы металлов с повышенным сроком стабильной работы. Даны основные характеристики плазменного потока для C , Cu и P катодов. Приведены экспериментальные данные для электронной и ионной компонент плазменных потоков в выбранном режиме работы.

Работа выполнена в Отделе новых методов ускорения ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна 1985

Taraszkiewicz R. E13-85-666
Simple High-Stability Metallic
Plasma Source

The data on high stability electro-discharged metallic plasma source are presented. The main characteristics of the plasma flux for C , Cu , and Pb cathods are examined. The experimental data for electrons and ions components of the plasma flux at chosen operating mode are performed.

The investigation has been performed at the Department of New Acceleration Methods, JINR.

Communication of the Joint Institute for Nuclear Research. Dubna 1985