PARAMETRIC STUDIES OF A VACUUM SPARK X-RAY SOURCE

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Dissertation submitted for the degree of

Master of Science

at the

University of Malaya

July, 1995

ABSTRAK

Alat "vacuum spark" merupakan salah satu alat plasma denyutan mudah yang boleh digunakan untuk menghasilkan sinar-x keras dan lembut. Walaubagaimanapun, mekanisma penghasilan sinar-x ini masih belum diketahui sepenuhnya.

Di dalam tesis ini, kajian-kajian kamilan-masa dan kerbeda-masa ke atas sinar-x yang dihasilkan dari alat "vacuum spark" telah dijalankan. Kajian ini dibahagikan kepada dua bahagian. Pada mulanya, pelbagai konfigurasi elektrod digunakan untuk menentukan konfigurasi yang dapat menampung voltan pengecasan dan menghasilkan sinar-x yang berkeamatan tinggi bila didiscaskan. Bagi tujuan ini, nilai voltan pengecasan ini ditetapkan pada 20 kV kerana bagi voltan pengecasan kurang daripada 15 kV hanya sedikit atau tiada langsung sinar-x yang dihasilkan. Didapati bahawa konfigurasi elektrod yang sesuai adalah dengan katod berdiameter 4 mm dan jarak pemisahan anod-katod sebanyak 2 mm.

Dengan menggunakan konfigurasi elektrod ini, parameter-parameter plasma ditentukan dengan teknik "foil absorption". Suhu elektron dan diameter 'hot spot' dianggarkan di antara 2.0 - 2.8 keV dan 100 - 200 μm, masing-masing. Dengan menggunakan nilai-nilai ini dan keluaran isyarat diod PIN, maka ketumpatan elektron dianggarkan bernilai antara 4.7×10^{20} - 1.1×10^{21} cm^3. Jumlah kuasa sinaran dan jumlah tenaga sinaran 'hot spot' juga dihitung dan didapati bernilai $(4.0 - 6.2) \times 10^5$ W dan $(2.9 - 5.6) \times 10^{-3}$ J, masing-masing.

ABSTRACT

The vacuum spark is a simple pulsed plasma device capable of producing intense bursts of soft and hard x-rays. However, the mechanisms leading to the production of these intense x-ray bursts are still not completely understood.

In this thesis, time-resolved and time-integrated x-ray studies have been carried out on an electron beam initiated hollow cathode vacuum spark. The studies are divided into two parts. First, various electrode configurations are employed to determine the configuration that can withstand the charging voltage and produce intense emission of x-rays consistently when initiated to breakdown. The charging voltage is set at 20 kV since for charging voltages of less than 15 kV there are either little or no emission of x-rays. The electrode configuration that satisfies these requirements is that with cathode aperture of 4 mm and anode-cathode gap of 2 mm.

The plasma parameters obtained using this setup are estimated by the foil absorption technique. The electron temperature and hot spot diameter are estimated to be 2.0 - 2.8 keV and 100 - 200 μm, respectively. Using these values and the PIN diode output, the electron density is estimated to be between 4.7×10^{20} - 1.1×10^{21} cm^{-3}. The total emission power and total emission energy of the hot spot are calculated, which are $(4.0 - 6.2) \times 10^{5}$ W and $(2.9 - 5.6) \times 10^{-3}$ J, respectively.

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my deepest gratitude to my supervisor, Associate Professor Dr. Wong Chiow San, for his guidance, suggestions and encouragement throughout the course of my research. I would also like to thank the following individuals:

The Head of Physics Department and the Dean of Institute of Advance Studies for allowing me to use the necessary facilities at the Plasma Research Laboratory and the Pulse Technology and Instrumentation Laboratory, respectively.

Mr. Jasbir Singh for his technical assistance. Mr. Loo Wat Tim for machining the parts of the vacuum spark. Dr. Ong Chia Xian and Ms. Chin Oi Hoong for their many constructive suggestions and discussion.

Ms. Chia Yu Chi, Mr. Ng Kim Hooi, Mr. Kok Yip Cheong and Mr. Khoo Swee Khean for helping me one way or another and for keeping me company during the long hours of work.

Dr. Peter Choi and Ms. Carmen Dumitrescu-Zoita for suggesting the use of the slit-wire camera technique and for scanning the results from the slit-wire camera.

I would also like to thank my family and friends for their support, love and understanding.

I would like to dedicate this thesis to my future wife, Sundri, who waited patiently for me to finish this thesis.

This work was carried out under the University of Malaya R & D Programmes 04-07-04-40 and 02-07-04-033.

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