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Water-Window X-ray Source Driven by an Ignitron Pulser

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INTRODUCTION

The low-photon-energy flash x-rays such as the water-window x-rays are useful in order to perform x-ray microscopy[1,2] of organisms, and several condenser-discharge generators have been designed. Although most flash x-ray generators produce bremsstrahlung x-rays in the water-window range, the production of characteristic x-rays is effective in order to increase the water-window intensity.[3] In addition, the conversion efficiency of the electrostatic energies into characteristic x-rays increases by forming the plasma x-ray source[4-7] that consists of metal ions and electrons.

In order to increase the intensity of low-photon-energy characteristic x-rays, the effective electron accelerating voltage should be decreased as low as possible even when a higher condenser charging voltage is selected. In view of this situation, the surface-discharge capillary is quite useful to decrease the voltage and to generate stable discharges, and the linear plasma x-ray source can be formed. Using this capillary, the characteristic x-ray intensity may increase with corresponding increases in the capillary length by the conversion of bremsstrahlung x-rays into fluorescent rays.

In our research, we have formed the linear plasma x-ray source and have produced water-window x-rays by using a capillary.

GENERATOR

The block diagram including the main transmission line of a flash water-window x-ray generator is illustrated in **Fig. 1**. This flash x-ray generator is composed of a high-voltage power supply, a polarity-inversion ignitron pulser, an oil-diffusion pump, and a radiation tube with a capillary. The high-voltage condenser of about 200 nF in the pulser is charged up to 20 kV by the power supply, and the electric charges in the condenser are discharged to the capillary in the tube after closing the ignitron. In the present work, the pump evacuates air from the tube with a pressure of about 1 mPa, and the titanium anode and cathode electrodes are employed to produce L-series characteristic x-rays in the water-window range.

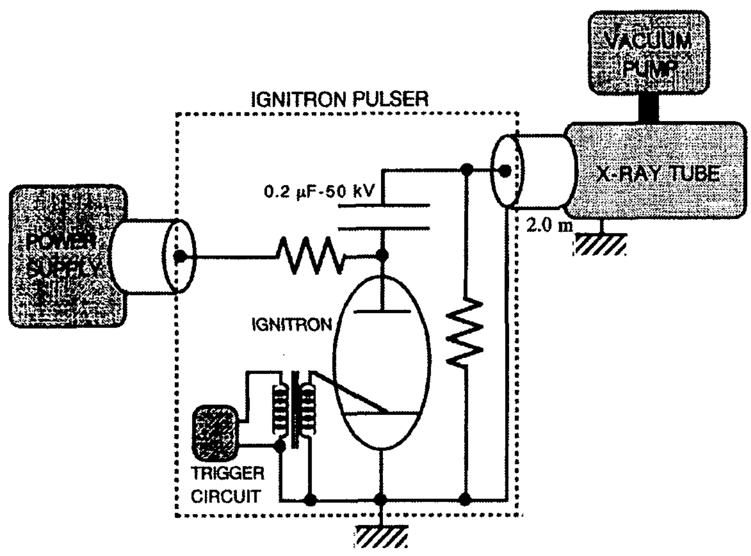

Fig. 1 Block diagram including the main transmission line of a flash water-window x-ray generator.

RESULTS

Figure 2 shows that the time relations among the cathode voltage, the discharge current, and the soft x-ray output. Both the cathode voltage and the discharge current displayed damped oscillations, and x-rays were produced during the damped oscillations. The first peak current had a value of bout 4 kA, and the effective x-ray duration was less than 20 μs.

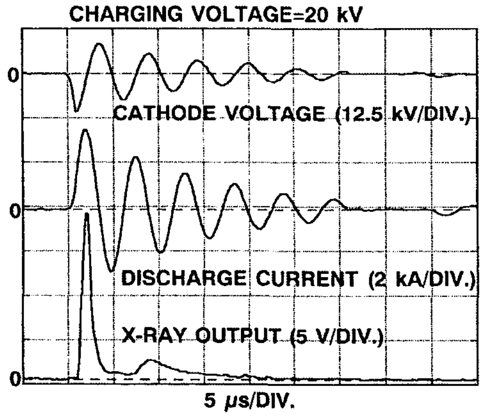

Fig. 2 Time relations among the cathode voltage, the discharge current, and the soft x-ray output.

Using this generator utilizing a ferrite-capillary radiation tube, we have obtained sufficient x-ray intensity per pulse by increasing the electrostatic energy in the pulser. Since the electron accelerating voltage can be effectively decreased by the surface discharging in the capillary even when a high charging voltage is employed, a high-speed soft x-ray microscopy will be accomplished by the PMMA regist technique utilizing the spin coater.

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