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High-Voltage Hollow-Cathode He–Cd+ Laser

by

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Summary. Performance and operation of a high-voltage hollow-cathode $He-Cd^+$ laser tube are presented. The laser action on green lines of Cd^+ was obtained much more efficiently than with conventional hollow-cathode tubes.

Historically, two basic types of hollow-cathode laser tubes have been developed, dictated mainly by the different direction of the motion of electrons and ions with respect to the axis of the hollow-cathode segment.

In the *longitudinal-discharge* hollow-cathode tubes the electrons after leaving the cathode surface are transported along the tube axis towards the anode.

In the *transverse-discharge* hollow-cathode tubes the electrons move towards the anode perpendicularly to the axis of the cathode segment.

Recently, we have been forced to distinguish two types of transverse hollow-cathode laser tubes—the *low-voltage* and the *high-voltage* ones.

On account of the different direction of motion of charges, the discharge parameters and laser excitation possibilities differ in both the longitudinal- and transverse-discharge laser tubes.

An outstanding example of longitudinal-discharge tube is the flute-type multi-anode design of Fujii *et al.* [1] with the help of which the white-light laser action was obtained.

A leading example of low-voltage transverse-discharge tube is the slotted hollow-cathode design of Schuebel [2] developed recently by Collins *et al.* [3] for UV laser oscillation study.

New opportunities for the development of hollow-cathode lasers have appeared since Rozsa *et al.* [4] proposed an improvement of the operation of hollow-cathode lasers by applying the internal anode system which enables the discharge to operate at higher voltage than that of conventional hollow-cathode discharge.

Reported in this paper for the first time, according to our knowledge, are results of investigations performed on an $He-Cd^+$ high-voltage hollow-cathode laser whose essential part was the internal anode system.

The tube (Fig. 1) consisted of six stainless-steel hollow-cathode segments with an internal diameter of 10.5 mm. The length of each segment was 10 cm. The six tungsten anodes were placed symmetrically inside the cathode, forming the internal anode system. Cadmium was supplied to the discharge from two side-arms placed at the ends of the tube. Two protective positive-column discharges at the ends of the tube were maintained to keep the cadmium vapour inside the cathode segments. To assure a minimum of temperature gradients along the active part of the tube, necessary for keeping a uniform axial distribution of the concentration of Cd atoms, the cathode temperature was accurately controlled with a heater.

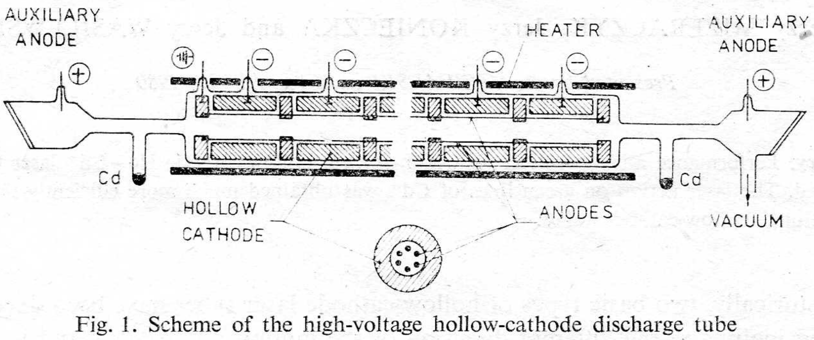

Fig. 1. Scheme of the high-voltage hollow-cathode discharge tube

Experiments (Fig. 2) confirmed the high efficiency of excitation of laser oscillation at green 0.5337 μm and 0.5378 μm. We have measured an output power of 5 mW at optimum conditions (helium pressure 15 hPa, total current ~2.5 A,

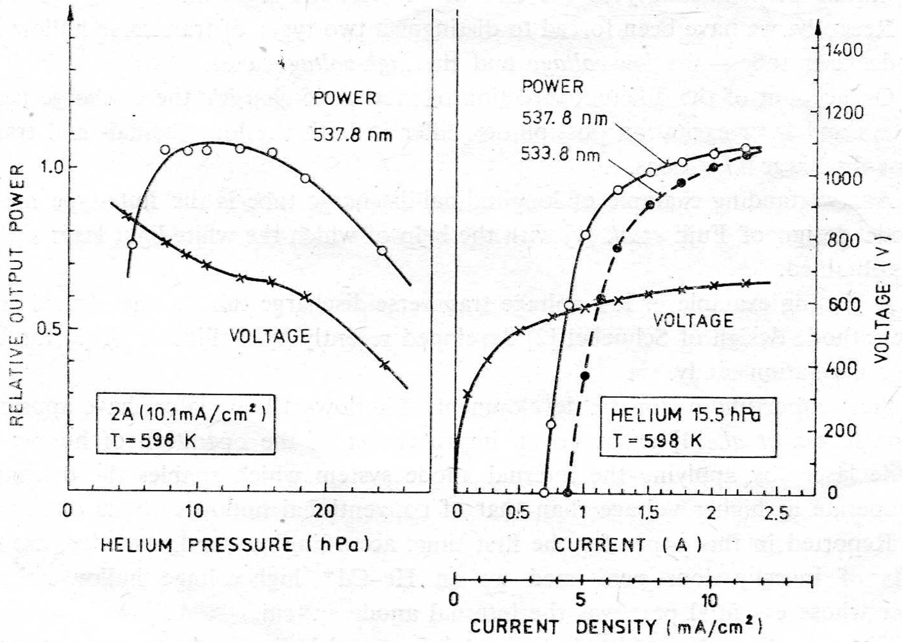

Fig. 2. Helium pressure and current dependence on laser output power and voltage at 598 K heater temperature