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CAPACITIVELY COUPLED RADIO-FREQUENCY EXCITED INFRARED He-Cd LASER

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Abstract. Laser oscillation on near-infrared cadmium ion transitions was obtained in a transverse radio- frequency excited He-Cd discharge. Lasing on two of them: 853.0 nm and 887.8 nm was reported for the first time as laser oscillation excited by a radio-frequency discharge. The optimum conditions at cw and pulsed mode of operation were determined yielding a maximum small signal gain coefficient of 24 %/m for the 806 nm laser.

The similarity between radio-frequency excited and hollow cathode discharges was proved by the infrared Cd^+ lines behaviour on discharge conditions.

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1. Introduction

The transverse capacitively coupled radio-frequency (RF) discharge was successfully employed for excitation of many gas laser systems. Laser action on a considerable number of ionic transitions of different metals and inert gases such as Ti, Cd, Zn, Hg, Se, Cu, Ar, Kr was realized [1-3]. Oscillation on all these transitions was previously obtained in a hollow-cathode (HC) discharge. In the negative glow of the HC discharge a group of high energy electrons exists providing good conditions for laser lines excitation. A similar mechanism of producing high energy electrons exists in the transverse RF discharge, in which at certain conditions a high electric field is formed near the electrodes [4, 5]. The correspondence between the two types of discharges was proved by the comparable laser output powers obtained in a hollow cathode and capacitively coupled RF excited discharges at nearly the same discharge conditions [6]. Besides, the capacitively coupled RF discharge possesses some advantages over

the HC discharge because of its better longitudinal homogeneity, the absence of arcing, and much simpler laser tube design.

One of the most promising as a practical RF excited laser is the capacitively coupled RF excited $He-Cd^+$ laser, capable of oscillating simultaneously on many lines in the whole visible spectrum. Recently, owing to a new discharge tube technology, a cw capacitively coupled RF excited white-light $He-Cd^+$ laser was developed exhibiting a reliable operation for more than 400 hours and delivering stable, tens-milliwatt power at the three primary spectral lines: blue ($\lambda = 441.6$ nm), green ($\lambda = 533.7$ nm and $\lambda = 537.8$ m), and red ($\lambda = 635.5$ nm and $\lambda = 636.0$ nm) [7].

Here we report simultaneous laser oscillation on five near-IR Cd ion lines: 723.7 nm, 728.4 nm, 806.7 nm, 853.0 nm, 887.8 nm in a He-Cd mixture using CCRF discharge excitation. To our knowledge generation on the 853.0 nm and 887.8 nm transitions was obtained for the first time in a RF excited discharge. The experiment comprised investigations of the laser oscillation characteristics at pulsed and cw modes of operation, at 27.12 MHz and 13.56 MHz excitation frequencies. The influence of the excitation pulse parameters on the laser parameters was examined. The small-signal gains of the laser lines were measured at pulsed and cw excitation.

2. Experiment

The laser tube (Fig. 1) had a design described in details elsewhere [7]. The laser tube envelope was made of a fused silica. The discharge active zone lengths were 400 mm. The Cd vapour was supplied into the discharge zone from a sidearm reservoir connected to the middle of the discharge tube. In our experiments we used two versions of the tube: (*a*) the discharge channel was formed by a fused silica capillary with $d = 8$ mm inner diameter, and (*b*) a capillary tube made of Al_2O_3 ceramic was

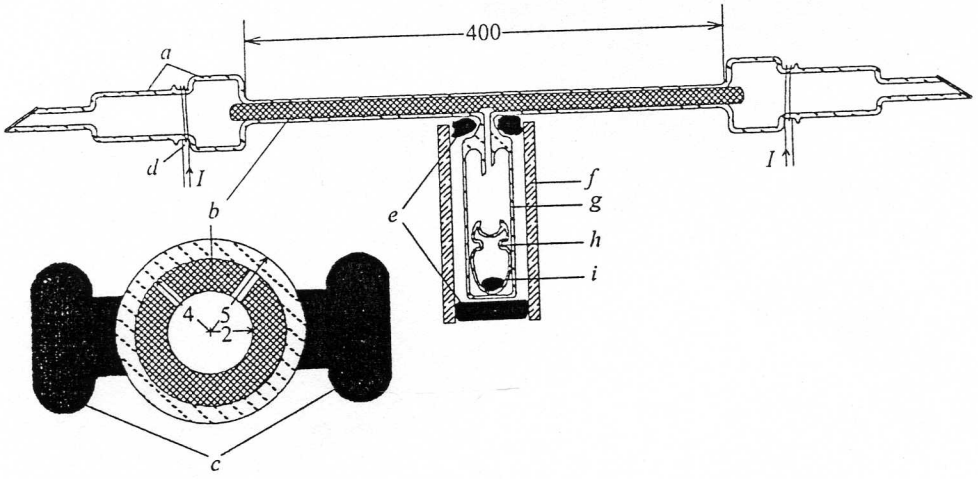

Fig. 1. Laser tube design

(*a*) fused silica tube; (*b*) Al(2)O(3) tube; (*c*) electrodes; (*d*) heater; (*e*) insulating material; (*f*) oven; (*g*) Cd reservoir; (*h*) ampoule; (*i*) Cd