

Preface

The goal of the present book is to introduce the investigation that was carried out to improve understanding of the formation characteristics of a self-controlled volume discharge for the purposes of pumping molecular lasers, i.e. self-sustained volume discharge (SSVD), which involved a preliminary filling of a discharge gap by an electron flux from an auxiliary-discharge plasma. We found that this method was suitable for large inter-electrode gaps, that distortion of the electric field in the gap by the space charge of the electron flux played an important role in the formation of the discharge and that the electrodes could be profiled dynamically during propagation of an electron flux through the discharge gap and an SSVD could form in systems with a strongly inhomogeneous field. High power SSVD-based CO₂ laser systems with an output of up to 30 kJ have been created, investigated and discussed in the book.

The second chapter of the book is devoted to another type of SSVD without pre-ionization, i.e. a self-initiated volume discharge (SIVD), in non-chain HF lasers with SF₆-C₂H₆ mixtures. We have established that, after the primary local electrical breakdown of the discharge gap, the SIVD spreads along the gap in directions perpendicular to that of the electric field by means of the successive formation of overlapping diffuse channels under a discharge voltage close to its quasi-steady state value. It is shown that, as new channels appear, the current following through the channels formed earlier decreases. The volume occupied by the SIVD increases with increase in the energy deposited in the plasma and, when the discharge volume is connected with a dielectric surface, the discharge voltage increases simultaneously with the increase in the current. The possible mechanisms to explain the observed phenomena, namely the dissociation of SF₆ molecules and electron attachment SF₆ molecules, are examined. A simple analytical model, which makes it possible to describe these mechanisms at a qualitative level, was developed. High power SIVD-based HF(DF) lasers with an output of up to 1 kJ have been developed, tested and evaluated.

The third part of the book discusses a wide spectrum of short pulse laser systems and investigations of different methods of high-power nanosecond pulses selection

from large-aperture CO_2 oscillators. In particular, we discuss a regenerative CO_2 amplifier of a nanosecond pulse train, nanosecond pulse transmission of buffered SF_6 at $10.6\text{ }\mu\text{m}$ and 20 J nanosecond locked oscillator (pulse CO_2 laser system based on an injection mode). Creation of N_2O laser pumped by an SSVD and experimental problems of high efficiency for an electric-discharge N_2 laser are based on the same technology of sophisticated electric discharge and are also included in this part of the book.

The final, fourth part of the book is devoted to a set of different applications for high energy molecular lasers, such as stimulation of a heterogeneous reaction of decomposition of ammonia on the surface of platinum by CO_2 laser radiation. A number of interesting investigations are discussed in this part, including the influence of the pumping regime on lasing of an He-Xe optical-breakdown plasma; formation of the active medium in lasers with rare-gas mixtures pumped by optical breakdown; low-threshold generation of harmonics and hard X-ray radiation in laser plasma. Interaction of CO_2 laser nanosecond pulse train with the metallic targets in optical breakdown regime and probe investigations of close-to-surface plasma produced by CO_2 -laser nanosecond pulse train are of particular interest. Finally, the wide aperture picosecond CO_2 laser system and new applications of short pulse laser systems conclude this chapter.

This book will be of very high interest to a wide audience, including students, scientists, teachers, and those with an intellectual interest in the area.

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