

Metal vapor lasers

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The traditional (13th) Symposium on Metal Vapor Lasers took place from 25 to 29 of September 2000 in Lazarevskoe village near Sochi on the coast of Black Sea. The program included 82 reports: more than twenty from Moscow, almost the same number from Tomsk, 12 from Rostov-na-Donu, and a little bit less from Novosibirsk. St. Petersburg, Kiev, Ivanovo, Obninsk, Raduzhny, Fryazino, Dolgoprudny, and Vilnius presented from one to two reports.

By the beginning of the Symposium, its program and abstracts of papers were published¹ (unfortunately, not all scientists presented their materials for publishing).

As usual, the Symposium was opened by Professor M.F. Sem (Rostov State University), Chairman of the Organizing Committee. He presented the members of the Organizing Committee and reminded the main landmarks of previous twelve symposiums and the purposes of this symposium. He presided at the first session.

The first report "Electric discharge cw lasers on self-limiting transitions of metal atoms with ionization depopulation of the lower laser level" was presented by Professor I.I. Klimovskii (Institute of Computer Engineering RAS, Moscow). The author touched upon the history of this subject and then passed to the main topic "Self-matching of electronic density and electronic temperature in the discharge of a metal vapor laser for obtaining continuous generation." Positive results were presented for barium and calcium. The report became the subject of a wide discussion.

In the next report "Continuous-wave lasers at $r - m$ transitions: problems and prospects," Professor G.G. Petrash (Physical Institute, RAS, Moscow) mentioned that the efficiency of gas lasers in the IR region achieves 40% (CO₂), whereas in the visible region it is only about ~1%. The report was devoted to possibilities of increasing the efficiency and mean power of collisional lasers and serious problems arising in realization of continuous generation.

Then G.S. Evtushenko (Institute of Atmospheric Optics, Tomsk) told about the XIII International Symposium on Gas Flow & Chemical Lasers and High-Power Lasers GCL-HPL'2000, he took part in. The Symposium was held in Florence from 18 to 22

September 2000; about 200 scientists, including 20 from Russia, participated in it. The Program included 145 papers; 65 among them were oral reports. In the section of metal vapor lasers there were 4 oral and more than 10 poster reports. The Institute of Atmospheric Optics (Tomsk) presented two reports (one poster and one oral).

Most reports in this section were devoted to copper vapor and copper halogenide lasers. The authors represented the main research groups in the field of metal-vapor lasers: Professor C. Webb (Oxford University), Professor N. Sabotinov with colleagues (Institute of Semiconductor Physics, Bulgaria), R. Mildren presenting the results obtained by the research group of Professor J. Piper (Macquarie University, Australia), E. Le Guyadec (CILAS, France), R. Riva (IEAv/CTA, Brazil).

The current achievements in the field of metal vapor lasers can be briefly formulated as follows: mean laser output power – up to 200 W per a meter of active length, efficiency – up to 4%, resource – thousands hour, including the case of sealed-off active elements, mean power of laser radiation converted in a BBO crystal – higher than 1 W. This opens up wide capabilities of applying this radiation (with high beam quality) to technological processes (at the wavelength of 255 nm).

Of largest interest is the study of metal halogenide lasers as most simple, cheap, and very competitive with metal vapor lasers in their technical characteristics. G.S. Evtushenko noted that, according to the current level of research in this field, Russia should be represented in such symposia by greater number of reports and participants (including invited papers). He addressed to participants of the Russian Symposium on Metal Vapor Lasers with a proposal to find the possibility to take part in the next (XIV) GCL-HPL Symposium that will be held in Poland in fall of 2002.

Coming back to the XIII Russian Symposium on Metal Vapor Lasers, it should be noted that in the first day more than 20 reports, including 10 posters, were presented. Every author of a poster had up to five minutes for a brief oral presentation, and then the posters were discussed for two hours. To be mentioned is the report by E.L. Latush (Rostov State University, Rostov-na-Donu) "Method of decreasing the electron

concentration between pulses due to rapid ambipolar diffusion." He reported that a pulse (heating) between pump current pulses accelerates ambipolar diffusion. I.G. Ivanov (Rostov State University) in his report "Plasma as a source of a beam of ions and metastables of inert gas to pump ion transitions in metal vapor lasers by collisions of the second kind" noted that krypton addition increases the helium ionization rate. The report "On dynamic matching of discharge circuit with active element of Cu-Br laser" by V.N. Kukharev (IAO, Tomsk) raised debates.

The research group from the Tomsk State University (A.N. Soldatov with colleagues) presented two posters, which preceded the oral review presented by A.N. Soldatov "Metal vapor lasers with parameters controlled through an electronic component" at the afternoon session.

The second day began with the report by A.R. Sorokin (Novosibirsk) "Modes of formation of electron beams in open discharge." The author gave his explanation to the mechanism of open discharge – secondary emission at cathode bombardment by heavy particles with a negligibly small role of photoeffect (what is hardly justified). For detail of this work see *Pis'ma Zh. Teor. Phys.* **46**, No. 24, 89–94 (2000). The report by A.R. Sorokin was followed by the report by O.O. Prutsakov, G.D. Chebotarev, and E.L. Latush (RSU) "Dynamics of longitudinal and transverse cathodoresis in repetitively pulsed metal vapor lasers."

The authors believe that their results indicate the prospects of using cathodoresis in repetitively pulsed metal vapor lasers for formation of active media and allow directed selection of excitation modes providing high degree of homogeneity. In addition, the results allow analysis of the processes of formation of radial pumping profiles in self-heating repetitively pulsed metal vapor lasers and determination of homogeneity conditions.

G.N. Tolmachev (Affiliate of the Institute of General Physics RAS, Rostov-na-Donu) in the report "Metal vapor lasers with transverse HF discharge" told about studies of He-Cd and He-Se lasers and minimization of the noise level. The report by G.A. Kalinchenko and I.G. Ivanov (RSU) "Simulation of processes in discharge with a hollow cathode in multicomponent gas mixtures" described He-Cd, He-Cd-Hg, and He-Kr-Hg models. The second day also included the poster session that took two hours before the afternoon session.

The afternoon session began with reports of scientists from the Institute of General Physics RAS (Moscow), namely Professor S.I. Yakovlenko, A.V. Karelin, O.V. Simakova, and A.M. Boichenko, on the kinetics of inert gas lasers. Professor G.G. Petrash (Physical Institute RAS) in the report "Effect of HBr on the electron energy distribution function in mixtures with metal vapors" (this work was done in co-operation with specialists from the Ivanovo State University) noted that addition of HBr into discharge with metal vapor in neon as a buffer gas significantly changed the electron energy

distribution function, making it not-Maxwell, including the region of low energy. With such a distribution function, the efficiency of "parasitic" population of low working states of a metal vapor laser is much lower than in the absence of HBr additions.

Two reports "Cavities in active optical systems with metal vapor amplifiers" and "Active optical systems and projection television" were presented by K.I. Zemskov (Physical Institute RAS). T.M. Gorbunova (Siberian Physical-Technical Institute, Tomsk) also presented two reports: "On the problem of development of pulsed high-voltage discharges with longitudinal configuration limited by dielectric walls" (whose conclusions looked quite questionable) and "Diagnostics of metal vapor active media," in which the emphasis was on the method of "Rozhdestvenskii hooks."

The morning session on September 28 began with the series of reports on laser isotope separation, the first of which was the report by Professor S.I. Yakovlenko (Institute of General Physics RAS) "Main problems in separation of weight amounts of rare isotope by the AVLIS (Atomic Vapor Laser Isotope Separation) method." Four reports devoted to this topic were presented by V.V. Buchanov and N.A. Yudin from the research group headed by Professor P.A. Bokhan (Novosibirsk). It should be noted that applications of metal vapor lasers to AVLIS technologies are now most attractive, especially commercially, because the cost of one gram of an isotope reaches hundreds (thousands) dollars (for elements having no volatile compounds).

Professor V.E. Privalov (Baltic State Technical University, St. Petersburg) presented the report "Lidars based on metal vapor lasers." In particular, the capabilities of remote sensing of iodine, hydrogen, and hydrocarbon molecules were studied in this work. The main direction of the research was to determine minimum atmospheric concentrations from the distance up to several kilometers and find the maximum distances, from which maximum permissible concentrations of these molecules can be detected. Different wavelengths of the copper vapor laser, including second harmonic, were used in calculations.

Representatives of the State Scientific and Industrial Enterprise "Istok" N.A. Lyabin and A.D. Chursin reported technical and operation characteristics, as well as the market of active elements for copper vapor lasers Kulon and Kristall. S.G. Kazantsev (Russian Laser Testing Center "Raduga," Raduzhny) presented the report "Thermomechanical mechanism of damaging IR optical materials at high-power continuous and repetitively pulsed irradiation." In this report, the author considered formation of pores, their growth, and development of cracks on optical elements, leading to their degradation.

The listed reports are not all reports presented, but they give an idea about the Symposium. The Symposium ended with the Round Table session, at which the participants discussed the prospects of research and applications of metal vapor lasers and adopted the Decision. In the Decision, it was noted, in particular,

that this year the traditional symposium was for the first time supported by the Russian Foundation for Basic Research. This probably caused the fact that the number of reports and participants, who published their abstracts for the first time, were larger as compared to the previous symposium.

The active work of the Organizing Committee was acknowledged. The Organizing Committee included representatives of the Rostov State University, Physical Institute RAS, Institute of General Physics RAS, Tomsk State University, Institute of Atmospheric Optics, Institute of High-Current Electronics, and Baltic State Technical University. Young scientists and postgraduate students appeared again among the participants (and even presented oral reports). This was a good sign. Therefore, it was decided to appeal to the Target Program "Integration of Science in Universities

and Academic Institutes" for financial support for the next XIV Symposium on Metal Vapor Lasers that will be held in fall of 2002.

In conclusion, some future events were announced. In particular, G.S. Evtushenko announced the Conference on Atomic and Molecular Pulsed Lasers – AMPL–2001 to be held in fall of 2001 in Tomsk (see the web site <http://symp.iao.ru>). V.E. Privalov announced the Conference "Lasers. Measurements. Information," which will take place in June 6–8, 2001, in St. Petersburg (for more information, mail to scipro@bstu.spb.su).

Reference

1. *Abstracts of Reports at Symposium on Metal Vapor Lasers*, Lazarevskoe, September 25–29, 2000 (Publishing House of the Rostov State University, Rostov-na-Donu, 2000), 64 pp.