Alkali Lasers

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Alkali vapor lasers are a new type of gas lasers, developed during the last several years. These lasers have potential for very important applications. In this paper we present a review of our main results and recent achievements in alkali laser development, discuss some possible applications of these lasers.

Optically pumped alkali vapor lasers developed during the last several years have attracted increasing attention because of their potential to achieve high power in a high quality beam. At the same time, these lasers have a number of desirable features as compared to other high power lasers. The quantum efficiency is high (e.g., 95.3% for Cs, 98.1% for Rb and 99.6% for K as compared to 76% for a 1.06 μm Nd: YAG laser), the gain medium (gas) has an excellent optical quality and these lasers do not use large quantities of hazardous materials. These lasers can be used not only for technological applications (welding, cutting, etc.) but also for such applications as laser cooling and producing of the spin polarized noble atoms, where the narrow-linewidth light, which can be precisely detuned around specific hyperfine resonances, is required.

The Laser and Optics Research Center of the US Air Force Academy started research program on optically pumped alkali lasers in 2004 and now it is a world leader in this field. A variety of different experiments on lasing of alkali vapors using Ti:Sapphire and diode lasers pump were performed in our lab and by other groups. Efficient operation of Rb, Cs and K vapor lasers with Ti:Sapphire laser pump [1-3] and with diode laser pump sources [4-6] was demonstrated. Using multiple LDAs pump we succeed to increase the output power of Rb laser to 17 W [7] and Cs laser to 48 W [8]. Additional possibilities in power scaling of alkali lasers can be provided by using diode pumped alkali vapor amplifiers, demonstrated in our recent experiment [9], where we obtained amplification factor of 145 for the low input signal. In this paper we present a review of the most important achievements in high power alkali lasers development, discuss some problems existing in this field and ways to solve them.

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