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ПИСЬМА В РЕДАКЦИЮ

SOLAR PUMPED LASER BASED ON COMPOSITE TITANIUM-SAPPHIRE ACTIVE MEDIUM

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$Ti^{3+}:Al_2O_3$ лазер фаол элементи асосида қуёш энергиясини лазер нури энергиясига айлантириш имконияти тадқиқ қилинди. Компьютер симуляцияси методи ёрдамида лазер фаол мухити концентрацияланган қуёш нури билан бўйлама йўналишда оптик дамланадиган (накачка қилинадиган) схема учун кристалл параметрларининг оптимал геометриясини танлаш орқали оптик дамлаш қувватининг чегаравий қийматини пасайтириш имконияти кўрсатилди.

Исследована возможность преобразования солнечной энергии в энергию лазерного излучения на базе активного элемента $Ti^{3+}:Al_2O_3$**.** Методом компьютерной симуляции показана возможность снижения порога генерации за счет выбора оптимальной геометрии параметров кристалла при продольной накачке концентрированным солнечным излучением.

On the basis of the active element of $Ti^{3+}:Al_2O_3$, the possibility of converting solar energy into laser radiation energy is investigated. By the computer simulations, it was shown the possibility of reducing the threshold pump power by choosing the optimal geometry of the crystal parameters for end-pumping scheme of concentrated solar radiation.

Laser materials are not divided into separate groups by the type of pumping (lump, diode, solar, nuclear, etc. types of pumping). Therefore, in principle, solar radiation can be used as a pump source for any laser material. However, under these conditions, special requirements are imposed on them: high thermal conductivity of the material to withstand the thermal load of the broadband spectrum of solar radiation, and a low lasing threshold (threshold pump power) due to the limited concentration of solar radiation. Nd: YAG crystal has found wide application as a laser material due to the relatively high thermal conductivity and low threshold pump power. At the same time, there are other laser materials, for example, $Ti^{3+}:Al_2O_3$, which by some of its characteristics exceeds Nd:YAG [1]. For example, it has better overlapping of the absorption spectrum with the solar radiation spectrum (Fig. 1) and high thermal conductivity (more than two times greater than that of Nd:YAG). However, it has a significantly higher threshold pump power with respect to Nd:YAG. For this reason, it was not considered as a laser material for lasers with solar pumping.

In this connection, in this paper we made an attempt to achieve laser generation with the help of optimal design solutions for $Ti^{3+}:Al_2O_3$, namely, ensuring the conditions under which the lasing threshold is reached and at the same time the effective conversion of solar energy into laser radiation energy takes place. To solve the problem, a computer

simulation was carried out within the framework of the model proposed by us [2, 3] and the possibility of reaching the lasing threshold was demonstrated.

Different variants of the laser scheme were considered. The most optimal of them, in our opinion, was the scheme shown in Fig. 2. In this case, the diameter of the concentrator was assumed to be equal to 1 m with a reflection coefficient of about 90%.

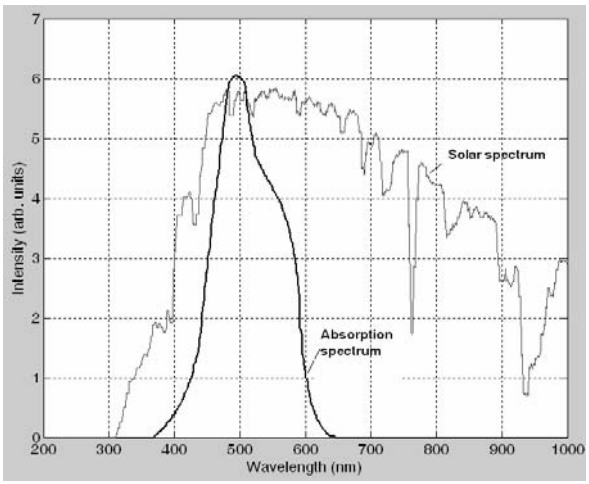

Fig. 1. Absorption spectrum of the active element of Ti^{3+}:Al_2O_3 and the standard spectrum of solar radiation AM1.5.

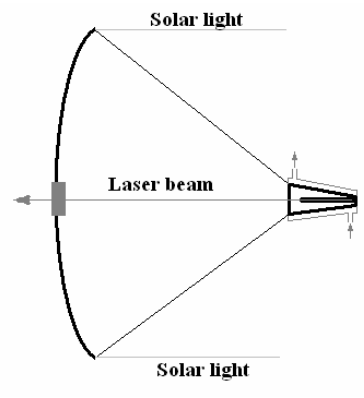

Fig. 2. Scheme of a solar laser with a composite active medium of Ti^{3+}:Al_2O_3.

As an active element, a composite active medium of Ti^{3+}:Al_2O_3 with a parabolic shape was considered. The parabolic composite material at the inlet end is coated with an antireflection coating to reduce the loss of incoming solar radiation and a highly reflective coating in the wavelength region of 700–1100 nm at the opposite end. The active element is placed in a cuvette for water cooling. The output mirror of the laser is located at the focus of the parabolic mirror-concentrator.

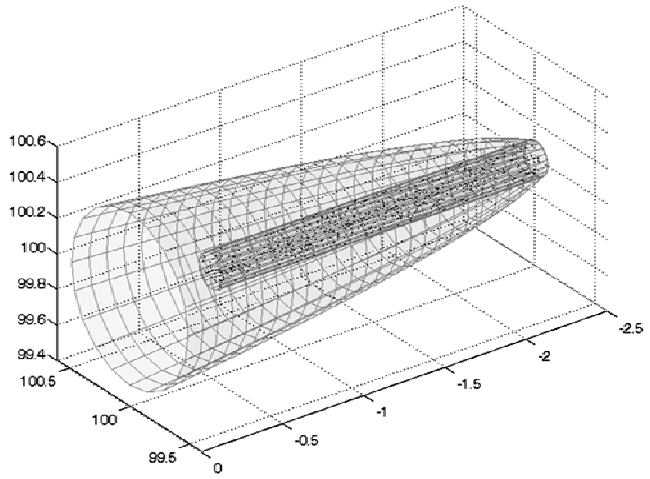

Fig. 3. Absorbed pump power density distribution in the active medium.

Figure 3 shows the absorbed pump power distribution in the composite Ti^{3+}:Al_2O_3 active element (dots in the active region of the crystal). As can be seen from Fig. 3, at the parabolic form of the active element with an active zone of Ti^{3+}:Al_2O_3 located along the central axis of the element, the pump density is uniform and, accordingly, the thermal load on the active element is also uniform. Heat removal occurs through Al_2O_3 in water. In this case, the active zone is separated from the input end at some distance. This helps to reduce the thermal load on the antireflection coating, and also improves the conditions for the thermal load on the active element as a whole.

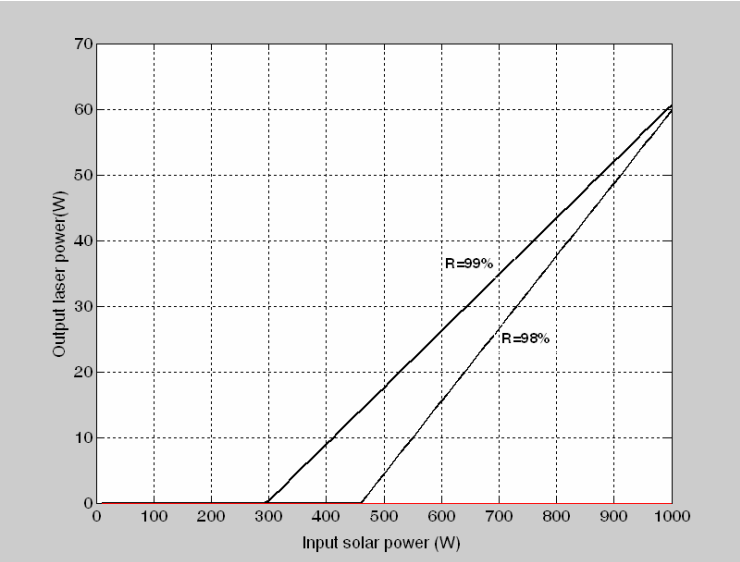

Fig. 4. Calculated laser power depending on the pump solar radiation power, and the dependence of lasing threshold on the output mirror reflectivity of *R* for the composite active medium

From the results obtained (Fig. 4) for the laser radiation power as a function of the pump power (solar radiation), it is clear that for a laser with an active element of Ti^{3+}:Al_2O_3, the conversion efficiency can be no less than in the case of solar pumped Nd: YAG laser.

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