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TUNABLE DIODE-PUMPED-LNA LASER

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ABSTRACT : Diode-pumped crystals provided recently new compact laser devices. We report the first end pumping of a $\text{La}_{1-x}\text{Nd}_x\text{MgAl}_{11}\text{O}_{19}$ (LNA) crystal using a 200mW diode array (Spectra Diode Lab). We also report the first results obtained with a 1mW diode (SONY). This C.W. laser can be tuned from 1.048 μm to 1.086 μm .

Without selective elements in the cavity, the laser emits around 1.054 μm with a threshold of 24mW and a slope efficiency of 4.4% (output mirror of transmission $T = 1\%$) when pumped by the diode array. With the selective elements, the threshold increases to 100mW and we obtain a power of 4mW for a pump power of 200mW.

Diode-pumped solid laser materials provide highly efficient as well as compact and relatively low cost laser devices leading to a wide range of potential applications [1]. End pumping of Nd:YAG crystals can deliver over 100mW of continuous power at 1.06 μm when pumped with diode arrays [2], the overall wall-plug efficiency being as large as 8% [1]. There is now a rapidly increasing number of neodymium doped material which has been shown to lase under diode excitation such as LiNbO_3 [11] or silica fibers [4]. Here we report the diode pumping of $\text{La}_{1-x}\text{Nd}_x\text{MgAl}_{11}\text{O}_{19}$ (LNA) [5,6] which is a crystal with laser characteristics similar to Nd:YAG or Nd:YAP [7] although with different crystalline symmetry. We also report the ability to tune the LNA laser output within the range 1.048 μm -1.086 μm .

An important difference between LNA and YAG is the Nd concentration, which can be higher in LNA than in YAG without quenching of the fluorescence [5]. This could be an advantage for future high-power lasers. LNA was recently found to be a slightly tunable infra-red laser with an efficiency comparable to YAG when excited by Ar or Kr lasers [8,9]. It oscillates at wavelengths significantly different from YAG, with a main peak around 1.054 μm and two other weaker peaks around 1.065 μm and 1.082 μm . The laser band around 1.065 μm had not been observed earlier. It corresponds to a weak fluorescence band actually observed in [5] and [9].

The LNA crystal is a cylinder, 5mm in diameter and 5mm in length, grown in LETI (Grenoble). The rod axis coincides with the crystalline c-axis. One of the two polished parallel faces is high reflectivity coated for the laser radiation and high transmission coated for the pump radiation. The other is antireflection coated for $\lambda = 1.06\mu\text{m}$. It is excited longitudinally by a C.W. diode focused on one end of the crystal. The set-up is shown in figure 1.

The diode emits at 800nm, wavelength within the absorption band of LNA [5,9]. The light emitted by the diode is collimated by corrected lenses of large aperture (Melles Griot 06 GLC 002).

To convert the diode output beam to a near-circular one, we use an amorphic

Fig. 1 : Cavity used for the LNA laser pumped by a laser diode

prism pair. Then we focus it on the crystal through a lens of focal length 10mm. The laser cavity consists of the high reflectivity coated face of the crystal and a plane output mirror M of low transmission $T = 1\%$ associated with an AR coated lens L of focal length 25mm. The total cavity length is approximately 13cm. the transverse waist of the gaussian beam in this cavity is of the order of $100\mu\text{m}$, matching the pump spot size.

Fig. 2 : Output power of the LNA laser (at $1.054\mu\text{m}$) as a function of the pump power on the crystal.

The two lines are for different laser diodes :

— SDL 2420 H1 diode array (200mW)
 ---- SLD 304V diode (1W)

The results are shown in fig. 2 without selective elements in the cavity the LNA laser emits on the main fluorescence peak at $1.054\mu\text{m}$. The output power is plotted as function of the pump power on the crystal, which absorbs 80% of the incident light when pumped by a diode array (model 2420 H1 from Spectra diode lab) delivering 200mW. The threshold is 24mW and the slope efficiency 5,5% (emitted power/absorbed power).

Pumping by a demonstration diode SONY emitting 1W around 80nm has been briefly tried [10] (model SLD 304V). The crystal absorbed 73% of this radiation. The threshold was 70mW and the slope efficiency 7,4% (emitted power/absorbed power). [The interfacing of the diode and the focusing optics was not optimized].

Tuning the frequency of the LNA laser was achieved by inserting a single plate birefringent Lyot filter F (a 1mm thick quartz plate) at Brewster angle in the cavity. Oscillation on the main peak at $1.054\mu\text{m}$ could be suppressed and tuning around $1.082\mu\text{m}$ was then possible. Fine tuning was accomplished with a thin, solid etalon E (a $100\mu\text{m}$ non coated plate of fused silica). The observed laser emission when pumped with a 200mW diode array is shown in fig.3.

Pumped by two 200mW diode arrays coupled through a polarizing beam splitter or pumped by the 1W diode (SONY), we can tune the laser on any of the wavelengths within the range $1.048\mu\text{m}$ - $1.086\mu\text{m}$. The laser beam is linearly polarized according to the Lyot filter orientation.

Fig. 3 : Output power of the LNA as a function of the wavelength. The pump power on the crystal is about 200mW.

In conclusion, LNA crystals can lase when pumped by diode, thus providing potentially a compact tunable source for atomic physics experiments.

REFERENCES

- [¹] T. BAER, Laser Focus, pp 82-92, June 1986.
- [²] T. BAER, Report at the CLEO conference San Francisco (June 1986).
- [³] D.L. SIPES App. Phys. Lett. 47, 74 (1985).
- [⁴] R.J. MEARS, L. RECKIE, S.B. POOK and D.N. DAYNE, Electron. Lett. 22 (1986) 159.
- [⁵] K.S. BAGDASAROV, L.M. DOROZHNIKIN, L.A. ERMAKOVA, A.M. KEVORKOV, Yu.I. KRASILOV, N.T. KUZNETSOV, I.I. KURATOV, A.V. SHESTAKOV, Sov. J. Quantum Electron. 13, 1082 (1983).
- [⁶] V.M. GARMASH, A.A. KAMINSKII, M.I. POLYAKOV, S.E. SARKISOV and A.A. FILIMONOV, Phys. Status Solidi (a), 75, K111 (1983).
- [⁷] G.A. MASSEY and J.M. YARBOROUGH, Appl. Phys. Lett. 18, 576 (1971)
- [⁸] D. VIVIEN, A.M. LEJUS, J. THERY, R. COLLONGUES, J.J. AUBERT, R. MONTCORGE and F. AUZEL, C.R. Acad. Sci. 298, 195 (1984).
- [⁹] L.D. SCHEARER, M. LEDUC, D. VIVIEN, A.M. LEJUS and J. THERY, IEEE J. of Quantum Electr. QE22, 713 (1986).
- [¹⁰] The authors thank Dr A. BRILLET for his assistance permitting the experiment.
- [¹¹] T.Y. FAN, A. CORDOVA-PLAZA, M.J.F. DIGONNET, R.L. BYER and H.J. SHAW, Journ. Opt. Soc. of Am. B 3, 140 (1986).