FLASHLAMP PUMPED COLOR CENTER LASER AT RT

D. Mounier, Sébastien Girard, J. Doualan, J. Margerie, K. Mazighi

► To cite this version:

D. Mounier, Sébastien Girard, J. Doualan, J. Margerie, K. Mazighi. FLASHLAMP PUMPED COLOR CENTER LASER AT RT. Journal de Physique IV Proceedings, 1991, 01 (C7), pp.C7-339-C7-341. 10.1051/jp4:1991790 . jpa-00251033

HAL Id: jpa-00251033

<https://hal.science/jpa-00251033>

Submitted on 1 Jan 1991

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

FLASHLAMP PUMPED COLOR CENTER LASER AT RT

D. MOUNIER⁽¹⁾, S. GIRARD, J.L. DOUALAN, J. MARGERIE⁽¹⁾ and K. MAZIGHI*Laboratoire de Spectroscopie Atomique (URA 19 CNRS) ISMRa, 6 boulevard Maréchal Juin, F-14050 Caen cedex, France***ABSTRACT**

The color centers can lase at RT or near RT if we use a pulsed pump. We describe a flashlamp color center laser at RT with (F_2^+) center in NaF Mg^{2+} and $(F_2^+)_{\text{H}}$ in NaCl OH. The lasers are tuned from 1.05 to 1.27 μm for (F_2^+) and 1.52 to 1.76 μm for $(F_2^+)_{\text{H}}$. The energy per pulse is few mJ. At RT the output power drops after few 10^5 pulses for (F_2^+) and few 10^3 pulses for $(F_2^+)_{\text{H}}$. If the NaCl OH crystal is cooled to -40° the $(F_2^+)_{\text{H}}$ laser emission is stable.

Flashlamp pumped laser are interesting for their simple building and their low cost. The flashlamp emission is very broad, it's possible to pump many color centers. For some of them it's necessary to use 2 wavelengths one for the pump the other one for the reorientation, in the flashlamp there is this 2 wavelengths.

The NaF Mg^{2+} crystal are grown by Bridgman technique in a graphite crucible, the doping is 10^{-2} mol % of MgF_2 . The samples are colored by an e^- beam 1.5 MeV at 100°C between 40 and 70 min with a current of $0.9 \mu\text{A cm}^{-2}$. The F_2^+ centers appear, when the crystal is warmed up to RT, these centers spontaneously transform into (F_2^+) centers in few hours in dark. The absorption and emission bands at RT for (F_2^+) centers in NaF Mg^{2+} are 0.85 μm and 1.09 μm respectively, typically the absorption is 6 cm^{-1} .

For the NaCl OH crystal we use the Kyropoulos technique, the NaCl powder is doped with NaOH and grown under Ar atmosphere. The doping is 10^{-2} mol % of OH. The sample is additively colored in sodium vapor at 700°C in heat pipe apparatus. During coloration OH are converted into O^{2-}

Before using the crystal is quenched, the colloid are converted in F centers. An exposure with F light ($\approx 500\text{nm}$) produces the $(F_2^+)_{\text{H}}$ centers

⁽¹⁾ Aussi Université de Caen, UFR de Sciences

The absorption and emission bands at RT are 1.05 and 1.55 μm respectively.

In these experiments we use a circular or parallelepiped rod with approximately 10mm² cross-section and a length between 15 and 50mm. This rod lies along a focal axis of an elliptical-cylindrical reflector. It's fixed to a copper block. A Xe flashlamp is at the other focal axis, it's cooled by a flow of water or other solutions. The pump pulse has between 10 and 20 μs . FWHM, the repetition rate is up to 2Hz and the maximum electrical energy per pulse is 19J. The laser cavity is limited by a concave gilt mirror (1m curvature radius) and a plane output mirror. The laser is turned with a prism inside the cavity.

The laser emission has been obtained between RT and 77K for $(F_2^+)^*$ centers in NaF Mg^{2+} [1]. Here we describe the RT laser emission. With 42% output coupling mirror the energy per pulse is 9mJ for 12J pump power. The lower threshold obtained is 0.3J for 2% output coupling. At the threshold the laser emission appears only at the top of the pump pulses. The energy is not stored in the excited state because its lifetime ($\approx 40\text{ns}$) is very small compared with the pump pulses (few μs). We can consider the pump power at the top of the pump pulse, it's 20KW. This value is very low but it's higher than a cw lamp ($\approx 2\text{KW}$). If the threshold is reduced by a factor 10 it would be possible to obtain cw laser emission with a lamp pumping. The losses in the cavity are 30%, the reflection on the rod and the transmission or absorption on the mirror give 10% of losses, the other 20% are unknown (diffusion, depolarisation,...). If we reduce noticeably the losses the threshold will be improved, but this color center is not a good material for cw lamp pumping because it's known [2] to bleach under high power excitation. Under flashlamp pumping we have measured a fading effect of the laser emission but we can use the rod during few 10^5 pulses before change it. This fading is the same between 77K and RT. With a prism the laser can be tuned between 1.05 and 1.27 μm .

The $(F_2^+)_H$ centers in NaCl OH⁻ laser [3] if 2 wavelengths are used one for the pump at 1.06 μm and a second one in UV or near 500nm for reorientation of the centers. In the spectrum of the flashlamp there is this 2 wavelengths. We have obtained pulse laser emission at RT and at lower temperature [4] with a great part of this spectrum from IR to 360nm. The output energy is 2.1mJ for 10J pump energy with 20% output coupling. The threshold is 0.9J for 5% output coupling, this value is higher than the threshold of the (F_2^+) center. The (F_2^+) absorption band is near the maximum of the Xe flashlamp emission.

Under polarized pump there is a reorientation of the center and the emission decreases, it's necessary to counter balance this effect for stable emission. An other polarization at the pump wavelength or an other wavelength to pump in an upper excited state stabilise the emission. The flash emission is not polarized, we must see any bleaching effect. With all the spectrum of the flashlamp the laser emission is stable at RT and 77K. If the short wavelength are cut ($< 660\text{nm}$) there is a quick bleaching at RT and not at 77K. The threshold is measured between 77K and RT, it's increased quickly around 150K, the centers are destroyed. There is 2 kinds of $(F_2^+)_H$ centers [4] one is stable at RT, the other at 77K, but the difference in the microscopic structure are not known. Over 150K after bleaching if we shine with the UV and visible part of the flashlamp spectrum the laser emission appears again, the centers are regenerated. More experiment will be necessary to understand the kinetic of these centers. This laser is tuned between 1.52 and 1.76 μm .

At RT we observe a fading effect in laser emission, the output power decreases significantly after 7000 pulses. It's better to work at 0°C the sample can be used during 10^5 pulses. If the crystal is cooled to -40° there is no fading effect after $1.5 \cdot 10^5$ pulses.

The flashlamp laser is easy to use and it's not expensive. With the same laser device and different color centers we have obtained laser emission in a part of the IR spectrum : $(F_2^+)_A$ SrF_2 Na (0.86-0.98 μm), F_2^+ NaF (0.87-1 μm), $(F_2^+)_A$ NaF Li (0.89-1.15 μm), (F_2^+) NaF Mg^{2+} (1.05-1.27 μm) and $(F_2^+)_H$ (1.52-1.76 μm).

- [1] D. MOUNIER, J.L. DOUALAN, S. GIRARD, J. MARGERIE AND K. MAZIGHI, Opt. Comm. 82 (1991) 314.
 [2] H. EISELE, H.J. PAUS, J. WAGNER and M. LEDUC, J. Appl. Phys. 54 (1983) 4821.
 [3] S. GIRARD, D. MOUNIER, J.L. DOUALAN and J. MARGERIE, Opt. Comm. 82 (1991) 321.
 [4] W. GELLERMAN J. Phys. Chem. Solids 52 (1991) 249.