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HIGH EFFICIENCY FLASHLAMP-PUMPED TITANIUM:SAPPHIRE LASER

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ABSTRACT

A flashlamp pumped titanium sapphire laser has been operated with efficiencies approaching 1% using a fluorescent converter. Performance of specific fluorescent converters is described, and ways to further increase the efficiency of the titanium sapphire laser are discussed.

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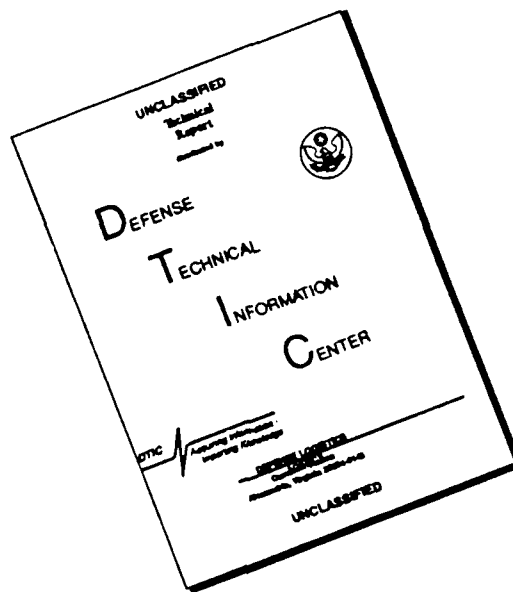
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## HIGH EFFICIENCY FLASHLAMP-PUMPED TITANIUM:SAPPHIRE LASER

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Development of the titanium:sapphire laser<sup>(1)</sup> has mainly been confined to laser pumping, because of its short (3.2 nsec) spontaneous emission lifetime. Esterowitz, et.al.,<sup>(2)</sup> reported successful flashlamp pumping of  $\text{Ti:Al}_2\text{O}_3$ , with efficiency enhanced by using a dye surrounding the laser rod to convert near UV light from the flashlamp into blue-green fluorescence overlapping the titanium absorption band. (Fig. 1) The present work describes successful attempts to substantially increase the flashlamp pump efficiency, and to better characterize flashlamp pumped behavior. In preliminary results a slope efficiency of approximately  $3 \times 10^{-4}$  was obtained<sup>(2)</sup>. Currently efficiencies approaching 1% are being realized.

An AR coated laser rod 6.3mm x 100mm long, with a pumped length of approximately 90mm is used. The rod was cored along the growth axis of the boule,  $90^\circ$  with respect to the C axis. The rod is held by stainless steel rod holders, with the dye solution-fluorescent converter flowing in the annulus between the rod and a UV grade quartz flow tube. Several other liquid fluorescent converters were tested, including laser dyes, rare earth salicylates, and hydrocarbons, with limited success. Solid fluorescent converters such as Cerium-doped Lanthanum Beryllate were also tested.

## Lacovara: Titanium:Sapphire Laser

Highest efficiency was obtained using an aluminum plated elliptical cavity, with flat aluminum plated end plates. Aluminum was chosen for its high reflectivity in the UV and blue regions of the spectrum. A close-coupled aluminum cavity and a barium sulfate diffuse reflecting cavity gave inferior performance. Mirror spacing is 40cm, with a flat output coupler and a 5 meter concave high reflector. Tuning was achieved with both a grating and prism over a spectral range exceeding 200nm.

A linear flashtube<sup>(3)</sup> was used with a 0.3  $\mu$ F low inductance capacitor and a spark gap, with the flashtube overvoltage triggered. Excellent pulse-to-pulse stability is obtained by wrapping a grounded wire outside the envelope adjacent to the high voltage electrode. Typical flashtube inputs range from 10 to 85 Joules, with a pulse-width of approximately 1  $\mu$ sec., and a repetition rate of 0.5 Hertz.

Highest laser output efficiency has been obtained with a coumarin 480 fluorescence converter and an 76% output coupler. With no dispersive elements inside the cavity, the laser output wavelength is determined by the mirror reflectivity curves and the titanium gain profile, with emission typically peaked at 788 nm, with an 8 nm FWHM. It is interesting to note that in decreasing the output coupler reflectivity from 99% to 76% the lasing threshold increased by only 2 Joules, while slope efficiency increased by a factor of twenty indicating that the laser is under-coupled. It is likely that a further decrease

**Lacovara: High Efficiency Flashlamp**

in output coupler reflectivity will further increase slope efficiency.

Our work indicates that there is considerable promise in flashlamp pumped titanium lasers. Preliminary calculations using tabulated outputs from present generation flashtubes indicate that an efficiency of about 5% could be achieved for a  $\text{Ti:Al}_2\text{O}_3$  laser with an improved fluorescent converter.

**REFERENCES**

- 1) P. F. Moulton, Laser Focus, p. 83, May 1983.
- 2) L. Esterowitz, R. Allen, C. P. Khattak, Stimulated Emission from Flashpumped  $\text{Ti:Al}_2\text{O}_3$ , presented at 1st Annual Conference on Tunable Solid State Lasers, La Jolla, CA.
- 3) FXQ-139C-3.5 EG&G, Electro-Optics, Salem, Mass.

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Caption for Figure 1

Overlap of coumarin 480 fluorescence with the titanium sapphire absorption band.

