Performance tests of quasi-CW laser diode pump arrays
conducted or sponsored by NASA Goddard Space Flight Center

Michael Krainak, Robert Afzal, Mark Stephen

NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

Gerald Browder, James Haden, Nils Carlson

SDL Inc.
80 Rose Orchard Way
San Jose, California 95134-1365

Abstract

We present tests of 100 W/bar quasi-CW laser diode arrays conducted, at SDL Inc. (at various deratings with constant junction temperature) and NASA Goddard, to assist in designing lasers for use in space.

Presented at the IEEE/LEOS 1997 Summer Topical Meeting on Advanced Semiconductor Lasers and Applications August 11-15, 1997, Montreal, Quebec Canada

Performance tests of quasi-CW laser diode pump arrays conducted or sponsored by NASA Goddard Space Flight Center

Michael Krainak, Robert Afzal, Mark Stephen

NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

Gerald Browder, James Haden, Nils Carlson

SDL Inc.
80 Rose Orchard Way
San Jose, California 95134-1365

Abstract

We present tests of 100 W/bar quasi-CW laser diode arrays conducted, at SDL Inc. (at various deratings with constant junction temperature) and NASA Goddard, to assist in designing lasers for use in space.

Several performance tests of quasi-CW laser diode pump arrays have been conducted[1] and documented. Space flight missions[2] are being considered which require diode lifetimes in excess of 2 billion shots with little available (greater than one billion shot) reliability data.

For the vendor conducted test (denoted Test 1), one SDL-3257-H6 device was started at 100 W/bar quasi-CW power, one SDL-3257-H6 device at 80 W/bar quasi-CW power, and one SDL-3257-H6 device at 60 W/bar quasi-CW power. Before the test began, the shot repetition rate was adjusted such that the device junction temperature was 30 C for every device. These devices were kept at the these optical powers throughout the test (i.e., constant optical power). The pump diode laser pulse width was chosen as 200 microseconds for all devices. The 100 W/bar device operated with a 450 Hz repetition rate (9% duty factor), the 80 W/bar device operated with a 533 Hz repetition rate (11.2% duty factor), and the two 60 W/bar devices operated with a 750 Hz repetition rate (15 % duty factor). The Test 1 data is shown in Figure 1. The Test 1 constant peak optical power lifetest shows a 5 to 7 times increase in the expected lifetime for the SDL Inc. laser diode pump arrays (rated at 100 W peak optical power per bar) when they are derated to 80 W/bar and 60 W/bar respectively. All of the bars operated with less than 20% degradation for over 2 billion shots. Predicted lifetimes exceed 20 billion shots for the bars that were derated to 60 W/bar.

The lifetime of the laser diodes varies inversely to the power loading at the facet and follows the power law:

$$Life(P_1) = Life(P_2) \times \left[\frac{P_2}{P_1}\right]^n \qquad (1)$$

The data was normalized relative one of the devices and the ratio of life time was plotted as a function of the ratio of operating peak optical power. It was found that the lifetime does vary inversely with optical power as in equation (1) with $n \cong 3.5$.

Presented at the IEEE/LEOS 1997 Summer Topical Meeting on Advanced Semiconductor Lasers and Applications August 11-15, 1997, Montreal, Quebec Canada

NASA Goddard conducted an independent laser diode performance test in at the NASA Goddard site. This test is described as follows. The NASA Goddard (Test 2) lifetest program used the Spectra Diode Lab 100 Watt/bar Peak Power Quasi-CW laser diode arrays. Initially, one SDL-3252-C3 package device was run for approximately 42 weeks (7 months). In this case we chose the vendor recommended repetition rate of 200 Hz. The diode was water cooled with the water kept at a constant temperature of 25 C. The diode optical power, current level, temperature and shot count were monitored and recorded twice a day. In addition, the room temperature and humidity were also monitored and recorded twice a day. A fail-safe circuit was developed so that the laser diode array power supply would automatically be shut off when the diode temperature exceeded 30 C. This prevented thermal runaway (catastrophic failure) if the water chiller failed.

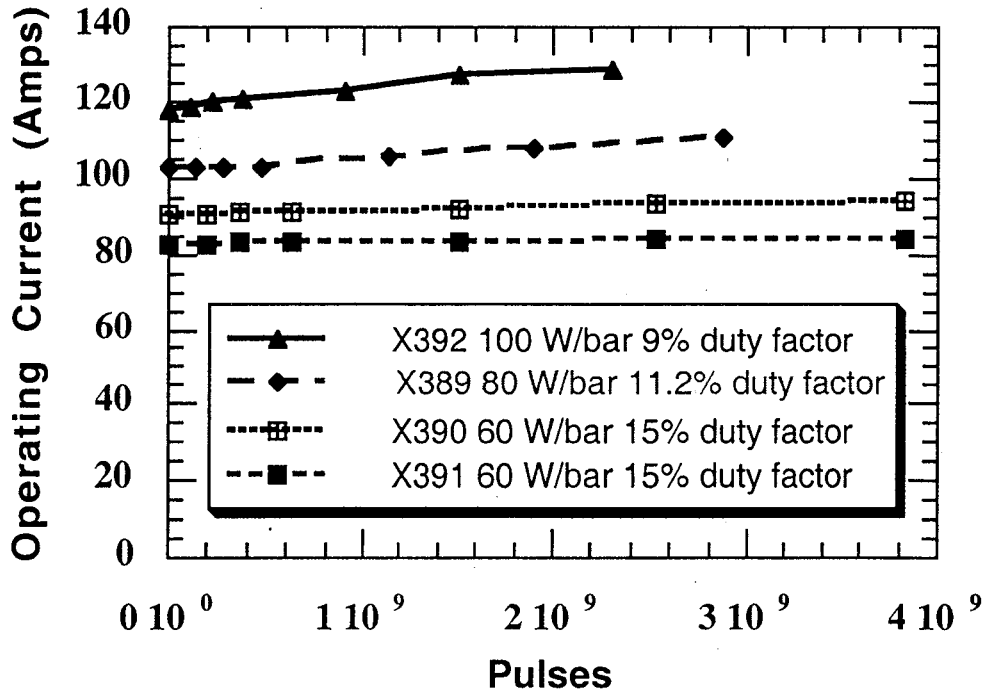

Figure 1. Vendor (SDL Inc.) performance test data of quasi-CW laser diode arrays (product is rated at 100 W/bar) with operating conditions as noted

The resulting test data from the initial run of the NASA Goddard in-house test showed a 20% degradation in diode power at ~5 billion shots.

Proof-of-principle reliability data now exists for the long term operation of the 100 W/bar quasi-CW product. In a third published NASA Goddard in-house test[3], the same SDL Inc. quasi-CW 100 W/bar rated laser diode product performance was measured and the 22.8% degradation end of life exceeded 7 billion shots.

References

1. Haden et al.. Proc. SPIE Vol. 2382, p. 2-21, Laser Diodes and Applications, Kurt J. Linden; Prasad R. Akkapeddi; Eds., (1995)

2. D. Schneider. Scientific American pp. 112-117 March 1997.

3. J. L. Dallas, R. S. Afzal, M. A. Stephen, Applied Optics Vol. 35 No. 9 1427 (1996).

Presented at the IEEE/LEOS 1997 Summer Topical Meeting on Advanced Semiconductor Lasers and Applications August 11-15, 1997, Montreal, Quebec Canada