SPACE LIDAR TECHNOLOGY CENTER

TECHNICAL MEMORANDUM – GLAS - 14

TO: Robert Afzal, GLAS Laser Chief Scientist
NASA-GSFC, Code 924

FROM: Boris Schroder, GLAS Laser Development Team
NASA-GSFC, Code 924.1
Space Lidar Technology Center

DATE: July 14, 1999

SUBJECT: Extreme Temperature Cycling of SDL G-Package Laser Dummy Arrays.

INTRODUCTION:

As part of a process improvement effort for q-cw G-package laser diode arrays at SDL, we have received two dummy packages for temperature cycling tests to investigate the solder joint between the BeO and the Au plated Cu heat sink of the diode package. Prior to this experiment we had already temperature cycled SDL G-package dummies which had been built using an older fabrication process. Those had been cycled between 5-35°C at a rate of 0.3°C/min. After inspecting the packages using the SAM (Scanning Acoustic Microscope) technique, we did not see any degradation in the solder joints.

The purpose of this test was to expose the arrays, which were fabricated using a new process, to faster transition rates as well as to more extreme temperatures in order to accelerate any solder joint failure mechanisms. The temperature cycle specifications were similar to those described in the MIL-STD 883E method 1010.7 (http://www.dscc.dla.mil/Programs/MilSpec/ListDocs.asp?BasicDoc=MIL-STD-883).

EXPERIMENT:

Setup:

The packages were mounted on a small aluminum plate with 5 in-lbs. of torque on the package's 4-40 mounting screws. No interface material was used to mount the diode package. The plate had a calibrated AD590 as a temperature sensor and a thermo-electric cooler (TEC) attached.(Fig.1) The cycling experiments were performed in ambient air at 23°C.

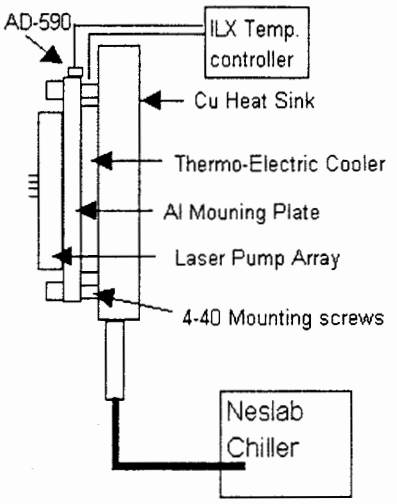

Fig.1

Temperature Cycling Specification:

We exposed the two newly processed dummy G-packages to a 10 cycle –20°C to +60°C range with transition times of up to 0.91°C/sec. and a dwell time of 10min. as shown in Fig.2

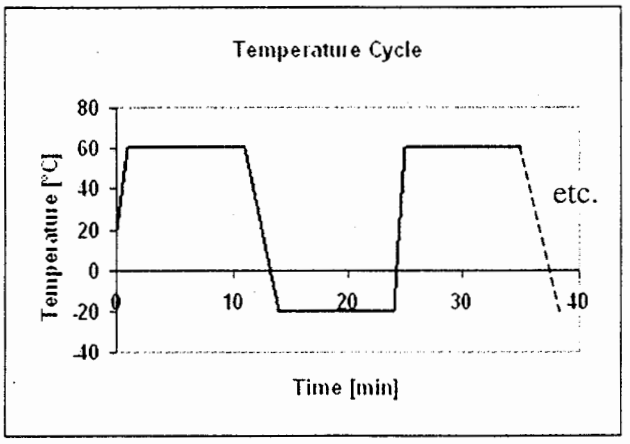

Fig.2

The following list shows the specification for the cycles in more detail.

- 10 cycles between –20° and +60°
- 10min. dwell time at both extreme temperatures
- 164 sec. transition time from +60°C down to –20°C (average rate of 0.48°C/sec.)
- 95 sec. transition time from –20°C up to +60°C (average rate of 0.84°C/sec.)

The experiment:
Prior to the thermal cycling test we took baseline SAM images of the solder joints of the two packages under investigation. The images are shown in Fig. 3a,b. We then exposed the dummy G-packages to the thermal cycles and did another SAM afterwards. The SAM images after thermal cycling are shown in Fig.4a,b.

ANALYSIS:

Post-cycling SAM analysis revealed no noticeable degradation of the BeO-Cu solder joints in either of the two packages.. Package #1 had a discontinuity percentage of approximately 7% of its total solder joint area. That discontinuity percentage did not change after the temperature cycles. The discontinuity percentage was calculated using a standard image processing threshold method.

Solder joints before thermal cycling:

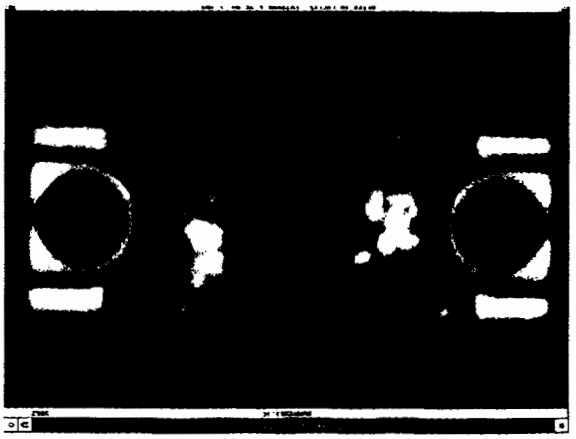

Fig.3 a (Package#1)

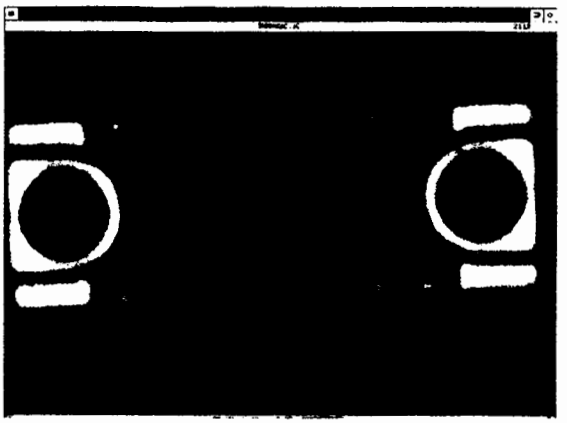

Fig.3 b (Package #2)

Solder joints after thermal cycling:

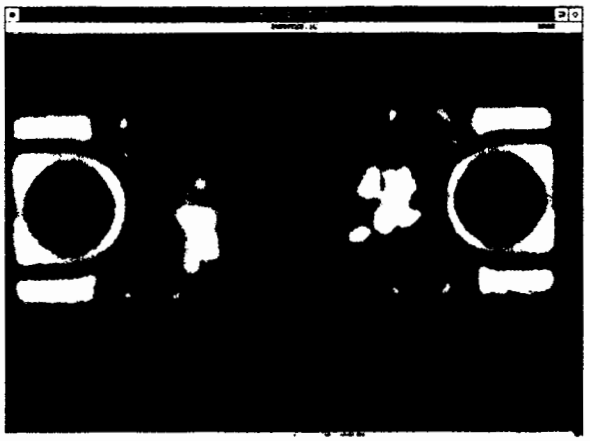

Fig.4 a (Package#1)

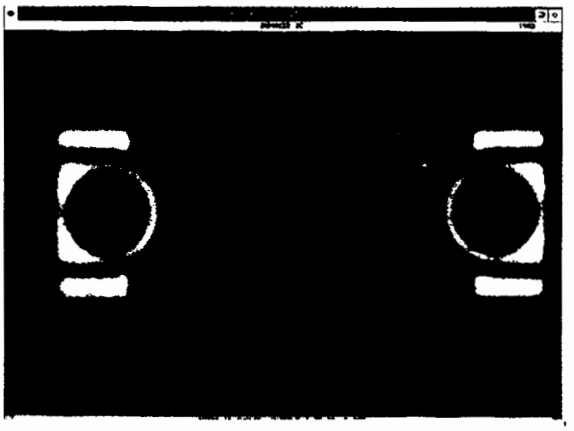

Fig.4 b (Package #2)

CONCLUSION:

The SDL dummy G-packages fabricated under a new process did not show any significant changes in the solder joints after the extreme temperature cycles, which is a very encouraging result. We would like to continue the solder joint investigation with a turn-on/turn-off cycle test to a recently received partially functional SDL-G11 package.

Please send all inquiries and comments regarding this memorandum to:
Boris I. Schroder
NASA/GSFC/ 924.1
Space Lidar Technology Center
5004 College Ave
College Park, MD 20740
(301) 403 4434(voice)
(301) 403 4642 (fax)
boris.schroder@gsfc.nasa.gov