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Development of semiconductor diode laser assemblies for extreme operational conditions of temperature, thermal and mechanical shock, and vibration

Mark McElhinney
Lasertel, USA

Abstract

The reliability of semiconductor diode lasers has improved to the point where in many applications the failure mechanisms are related to the robustness of the assembly and packaging of the laser diodes rather than failure mechanisms intrinsic to the diodes themselves. Aerospace applications require operation at high levels of vibration and mechanical shock, at temperature extremes and during temperature cycling.

Lasertel has developed laser diode assemblies that have been qualified for use in the space shuttle, as well as on many fast jet and rotary wing platforms. Assembly technology based on the utilization of expansion matched high thermal conductivity materials and high temperature solders has enabled Lasertel to produce laser assemblies with performance and reliability that excel in environmentally demanding applications. The environmental conditions to which assemblies have been qualified include: thermal shocks of 100ºC with temperature ramps of 220ºC/minute; operational thermal cycling between -60°C to +100°C;high temperature operation at 85ºC; low temperature operation at -200ºC; random mechanical vibration of 50g; and mechanical shocks of 500g per axis.

More recently, Lasertel has developed 8XX nm laser diode assemblies for an artillery application that exhibit record high-temperature (180^{o}C) operation. At the operating temperature of 130^{o}C required by the application, the laser assemblies have peak powers of 1.3kW. Diode pumped Nd:YAG solid state laser modules incorporating these assemblies were operated from -45^{o}C to 130^{o}C under high shock (~10000 g) conditions, while attached to the artillery weapon. The pump modules met performance specifications and showed no degradation during testing.

Biography

Mark McElhinney is the President of Lasertel. He obtained his Ph.D. from the University of Glasgow and holds 8 patents and has published over 30 papers.