State of the art of compact green lasers for mobile projectors

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Abstract: *We report on progress in development of the low-cost, highly efficient miniature diode-pumped solid-state (DPSS) green laser sources for pico-projectors and other consumer electronics applications with wavelength 532nm. Two DPSS green laser designs with discrete and monolithic architectures will be reviewed.*

1. Introduction

Growing pico-projector market demands RGB light engine based products with higher brightness and longer battery life. Laser-based pico-projectors can meet both requirements [1-3]. Blue and red semiconductor direct lasers with wavelengths of 445nm and 640nm are available from a number of vendors. At the same time prototype direct green diode lasers that are available now still lack efficiency and output power required for the efficient projectors with high brightness of more than 20 lumens [4, 5]. In RGB light source, a green laser is the major lumen provider (Table 1), therefore development and production of compact, efficient, low cost and high power green laser is critical for commercialization of laser pico-projectors. We discuss progress in development of the low-cost, highly efficient miniature diode-pumped solid-state (DPSS) green laser sources for pico-projectors and other consumer electronics applications with wavelength 532nm. Two DPSS green laser designs with discrete and monolithic architectures will be reviewed.

2. Composite Green Laser with Descrete Architecture

The laser is based on intra-cavity second harmonic generation of 532nm of DPSS laser. The laser cavity has discrete structure and consist of Nd:YVO_4 gain crystal, highly efficient periodically poled MgO-doped Lithium Niobate (PPMgOLN) as the frequency doubler and output mirror [6]. Reliable operation with high peak power of 1000mW with overall efficiency higher than 15% when operating in pulsed regime with duty cycle of 33% required for field sequential LCOS- based projectors has been demonstrated. The laser package volume can be as small as $2cm^3$.

2. Composite Green Laser with Monolythic Architecture - Microchip

The laser is based on the monolithic microchip cavity with optically-bonded Nd:YVO_4 gain medium and highly efficient periodically poled MgO-doped Lithium Niobate as the frequency doubler [7]. This design allows high power output while maintaining small package size. We demonstrate reliable operation with high peak power of more than 360mW (average output is 120-200mW) and with overall efficiency higher than 14% when operating in pulsed regime with duty cycle of 33% required for field sequential LCOS- or DLP- based projectors. The laser package volume can be as small as $0.23cm^3$ with height of 4mm – meeting stringent requirements for pico-projector engines (Figures 1 and 2). We report on progress in development of the low-cost highly efficient miniature green laser designed for battery powered high-brightness pico-projectors. Brightness of the pico-projector powered by 120mW green laser operating in pulsed regime with duty cycle of 33% sequential LCOS- or DLP-based projectors could be as high as 50 lumens (Table 1).

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Table 1. RGB laser light source efficiency and lumen output referenced to a 120mW green laser [8]

	Red, 640nm	Green, 532nm	Blue, 450nm
Photopic response	0.175	0.885	0.038
Lumens per 1 Watt of laser output	120	604	26
Fractions for D65 white, % per lumen	23.1%	74.7%	2.3%
Fractions for D65 white, % per mW	47.8%	30.6%	21.7%
Average output power, mW	187.3	120.0	84.9
Average luminous flux, lm	22.4	72.5	2.2
Wall-plug efficiency, %	25%	14%	10%
Electrical power consumption, W	0.75	0.86	0.85
Total RGB output in D65 white, lm	97		
Total electrical power consumption, W	2.5		
RGB laser source efficiency, lm/W	40		

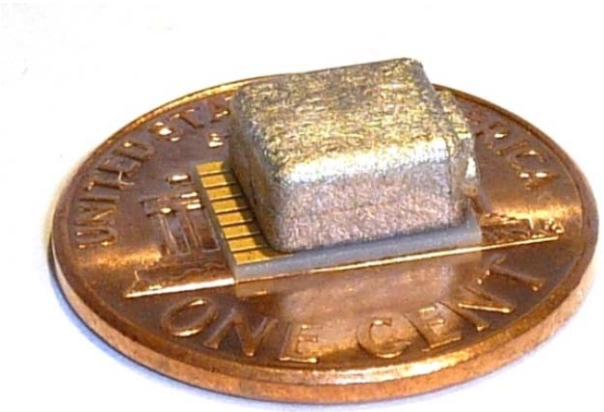

Figure 1. ATTO-K miniature laser package developed by Spectralus pictured on one US cent coin

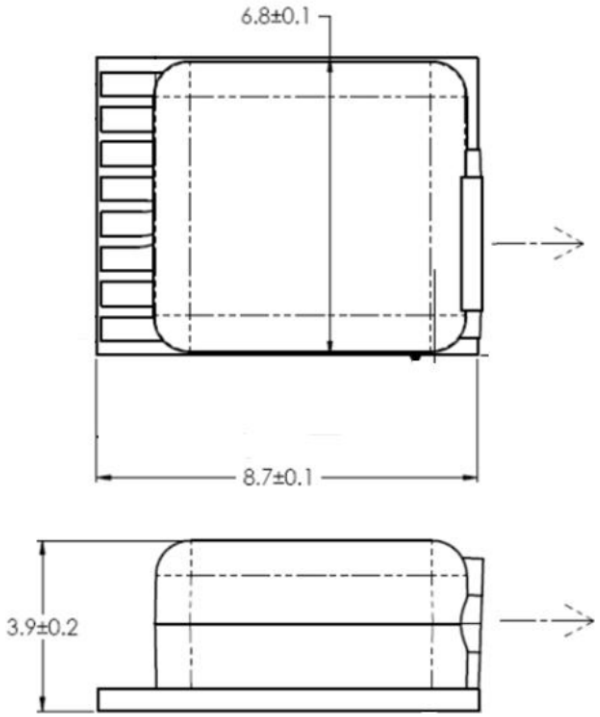

Figure 2. Drawing of ATTO-K miniature laser package developed by Spectralus