

A Compact Full-color Laser Beam Scanning Image Projector Based on a Waveguide-type RGB Combiner

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ABSTRACT

A packaged RGB laser module is demonstrated. Its size reaches as small as 8x4x3 mm. A compact RGB laser scanning module is also demonstrated. Since the modules are based on the waveguide-type combiner, each combined output beam is perfectly aligned. Clear full-color high-definition video images are obtained by using them.

1 INTRODUCTION

Compact image projectors such as eyewear displays have been extensively investigated [1, 2]. In particular, laser projectors using beam scanning units have occupied an important position in this field because of their size compactness and clearness of the obtained image [3, 4].

Recently, we have realized a new waveguide-type red-green-blue (RGB) laser beam combiner, which is integrated with semiconductor lasers [5-8]. This integrated laser source is so small that it can be applied to the laser beam scanning projectors including eyewear displays.

Here, we demonstrate its packaged RGB laser module and a compact RGB laser beam scanning projector using it.

2 RESULTS AND DISCUSSION

2.1 RGB Laser Module

The waveguide-type RGB laser beam combiner integrated with RGB semiconductor lasers is schematically shown in Fig. 1. The measured multiplexing efficiency of the combiner itself reaches as high as 97%

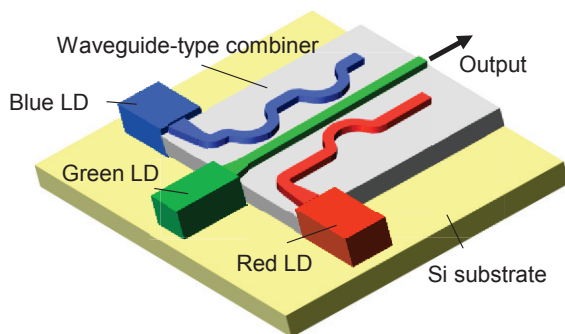


Fig. 1 Waveguide-type combiner with RGB LDs

(0.13 dB down) on RGB average. The laser beam emitted from each laser is illuminated into each waveguide input of the combiner. The combiner and RGB lasers are assembled on the same Si substrate. A typical near field pattern of the output laser beam for each color is shown in Fig. 2. As shown, clear symmetrical patterns can be obtained. In addition, each RGB output laser beam is perfectly aligned because of the inherent nature of the waveguide-type combiner.

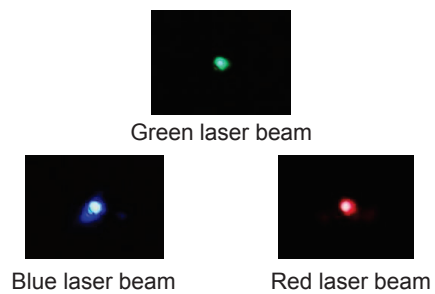


Fig. 2 Output laser beam patterns

These modules are packaged as shown in Fig. 3. There are two types of packages, depending on the focusing lens position (inside or outside). The package size is 10x5x5 mm for the lens-outside type and 8x4x3 mm for the lens-inside type. Since an achromatic lens is used, an excellent circular focused beam with no chromatic aberration can be obtained.

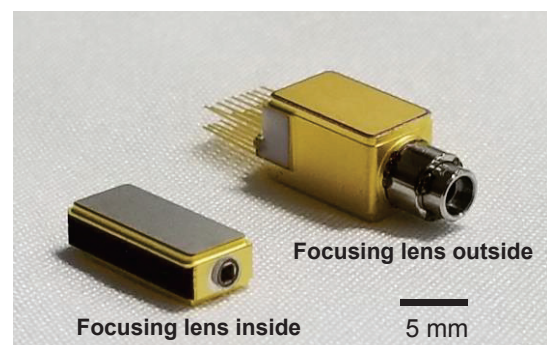


Fig. 3 Packaged RGB laser modules

A collimated beams can also be obtained. The typical beam diameter is 0.5 mm ϕ . Much larger beam diameters are available by changing the focal lenses.

2.2 RGB Laser Beam Scanning Module

By using the above RGB laser module, we have assembled a RGB laser beam scanning module. Its basic configuration is shown in Fig. 4. A MEMS (Micro Electro Mechanical Systems) mirror for two-dimensional (2D) beam scanning is attached to the mount. Here, the mirror is tilted to the incident laser beam because of the efficient laser beam reflection.

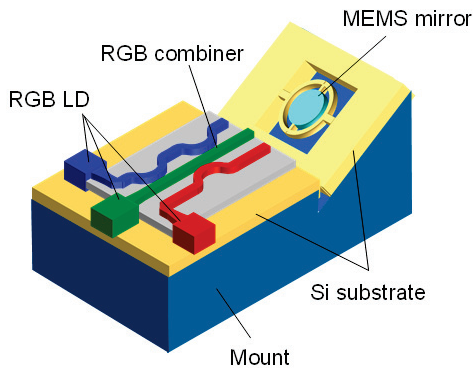


Fig. 4 Configuration of a RGB laser beam scanning module

The fabricated RGB laser beam scanning module is shown in Fig. 5. In this case, we use the packaged RGB laser module shown in Sec. 2.1. FPC (Flexible Printed Circuit) cables for driving lasers and a mirror are connected. The optical scan angle is about 50 deg. for fast scan and its half angle for slow scan. The fast scan resonant frequency is about 30 kHz and the slow scan is driven by DC input. Both of collimated and focused laser beams can be obtained by easily changing the structural parameters of the scanning module.

Clear full-color video images with 1280x720 pixels have been obtained by using the above RGB laser beam scanning module.

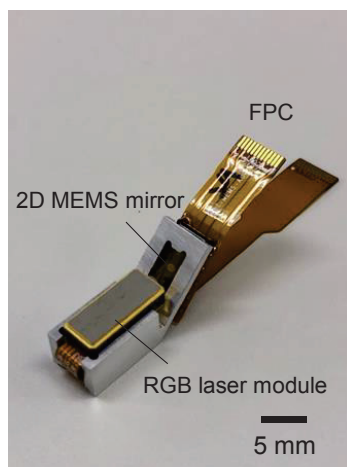


Fig. 5 Fabricated RGB laser beam scanning module

3 SUMMARY

We have successfully constructed a compact packaged RGB laser module. Its size reaches as small as 8x4x3 mm. A compact RGB laser beam scanning module has also been constructed. Since the module is based on the waveguide-type RGB combiner, each RGB output laser beam is perfectly aligned. Clear full-color high-definition video images have been obtained by using these RGB laser beam scanning modules.

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