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Evaluation of RGB-LD generated photoacoustic images
R/G/B 半導体レーザーを用いた光音響像の評価

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1. Introduction

The photoacoustic microscope (PAM) has been revealed effective tool for the nondestructive detection of the surface and undersurface defercts.[1,2] For spectroscopic imaging of various colored specimens in medical or biological specimens,[3,4] wavelength-tunable laser or R/G/B full-color lasers are the best candidates of optical sources for PAM.

After the invention of a blue light emitting diode(LED), blue laser diode(LD) has been available for commertial usevery recently. In this paper, RGB LDs were used as optical sources of the PAM measurement system. Several kinds of color paints were painted on a metalic specimens, and the differences of photoacoustic (PA) signals were measured in order to inverstigate how the difference of optical source colors (R/G/B) affects the differences of PA signals.

2. Experimental Apparatus and Specimen

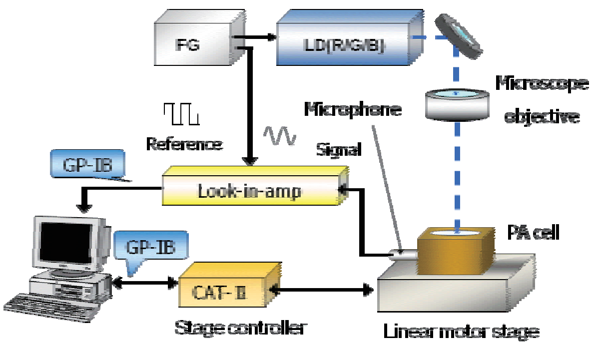

Fig. 1 Basic experimental setup

The basic experimental setup was similar to the previous publications and was shown in Fig. 1. Laser diodes with the wavelengths of 405nm and 660nm, and the second harmonics (SH) of LD-excited of YAG laser with wavelength of 532nm were used as full-color optical sources.

As a substrate, aluminum plate with a thickness of 2mm was used, and the paints commercially used for poster spray and lacquer spray were used as specimens. Green, blue, red, yellow, pink, light blue and white colors were painted on the aluminum plate as circle and rhomb shapes.

3. Experimental Results and Discussions

Measured area for PAM measurement was 27mm×27mm, and the modulation frequency was 90Hz. Adopted resolution was 65×65 pixels, or 100×100 pixels.

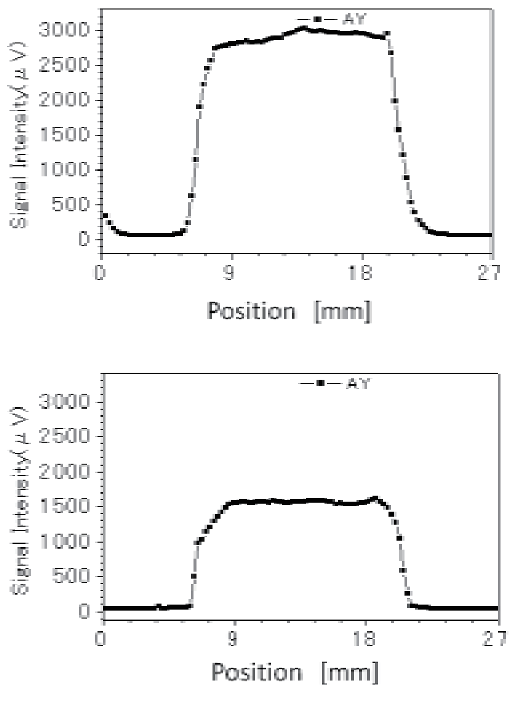

Fig. 2 PA signal distribution for (a) yellow specimen (upper), (b) blue specimen (lower)

The PAM images obtained for eight color specimens were obtained with excitation wavelength of 405 nm. The PA signal distributions for yellow and blue specimen were shown in Figs. 2 (a) and (b), respectively. The difference in PA signals for yellow and blue specimens corresponds to the reflectivity for these specimens as shown in the figures.

In principle, PA signals which are generated by the specimens are proportional to the amount of the heat absorbed by the specimens so that they will be proportional to the absorption [%] calculated by the 1-R (reflectivity).

Using the above principle, we measured optical reflectance spectra of color paints, and the spectra were summarized and shown in Fig. 3.

Correlation between absorptions of individual color paints at the wavelength of 405 nm and PA signals for corresponding specimens measured with blue LD (405 nm) was shown in Fig. 4, and the result showed that the correlation coefficient was R= 0.859.

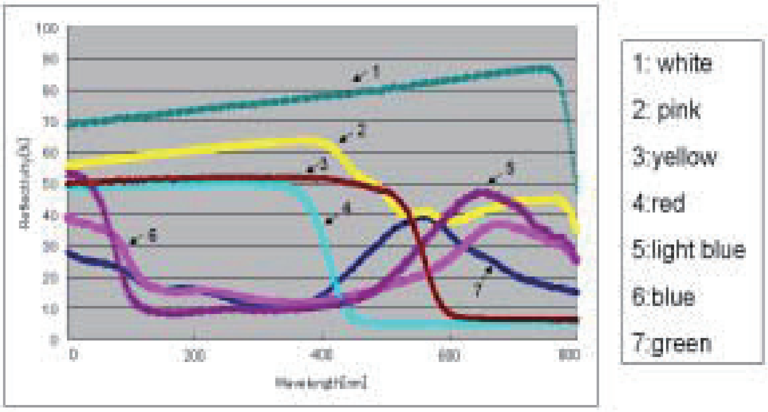

Fig. 3 Reflectance spectra of colored specimens

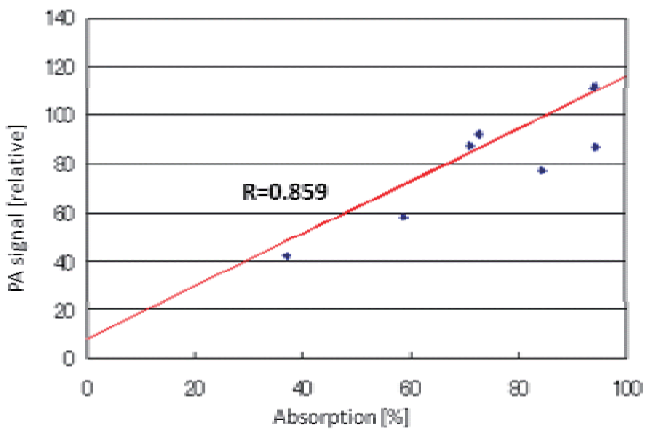

Fig. 4 Correlation of PA signal vs. absorption (1-R) at 405 nm.

The similar experiments of PAM and reflectivity measurements were carried out with green (532 nm) and red (660 nm) LDs. The correlation coefficients for green (532 nm) and red (660 nm) LDs were R = 0.927 and R = 0.932, respectively.

4. Conclusion

R, G and B-colored LDs were used as optical sources for PAM system. Optical reflectance measurements were performed for seven color paints used for specimens. Correlation between absorptions at individual wavelengths and PA signals for corresponding wavelengths excitation was good (more than 85 %).

The fundamental PAM experiments with R/G/B LDs will be used to fabricate a unified full-color PAM system, and it will be applied to quantitative spectroscopic measurements of colored specimens such as paper chromatography [5] or colored layered specimens in the near future.

References

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