

## A New Type of LD 3 Wavelength Pulsed Laser for PDD and PDT

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We developed an excitation laser and the spectrophotometer for the fluorescent diagnosis of tumor in the case of 5-ALA as shown in Figure 4. In actual, the removed tissue of glioblastoma was emitted the red fluorescence image shown in Figure 1 of Pp-IX 4hr after the oral administration of 5-ALA aqueous solution before the operation. Especially, in the labeled position of 1 area in the white light image (left upper image) of the GBM is emitted red as shown in the fluorescence image (right bottom image) will be fallen behind to remove in white light on the surgical operation.

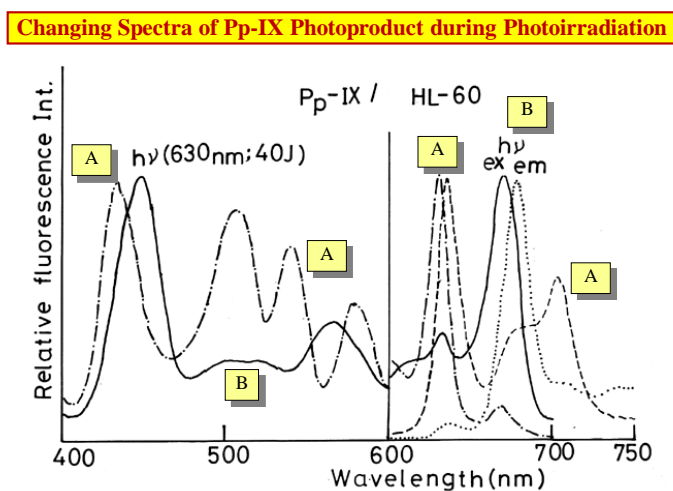
Figure 1.



On the other hand, we take to move on the PDT studies. The excitation spectrum of Pp-IX were changed from pattern A to B during the irradiation at 635 nm for 40J in the HL-60 cells suspension incorporated 5-ALA as shown in Figure 7. We observed the changing spectra (from A to B) of Pp-IX photoproduct during photo-irradiation At the

wavelength range more than 600 nm, the pair of fluorescence excitation (ex) and emission (em) spectra of A (Pp-IX) and B (photoproduct of Pp-IX) were normalized at the each peaks as shown in Figure 2. In actual, the excitation peak at 630 nm was decreasing with increasing the excitation peak at 665 nm during the photo-irradiation. As it has been reported about the photoproducts of Pp-IX by many researchers, chlorine derivative by Moan group (1, 2, 3), we can also estimate that it will be a chlorine-like derivative from the matting with the excitation (665 nm) and emission (670 nm) peaks of the derivative. Furthermore, the product plays photoactive as a photosensitizer as following figures. On the other hand, it was reported that the photoproduct will a hydroxyl aldehyde derivative of Pp-IX reported by Dietel, et al. (4) as the product of Pp-IX.

**Figure 2.**



We developed a dual-color (635, 670 nm) diode laser system (DLD-R<sup>2</sup>) produced from SMI-ALApromo Ltd. Co. (Tokyo) in Figure 8. Furthermore, we developed a new disk pulsed laser for three wavelengths at 659, 664, and 669 nm as shown in Figure 9. These laser will be used for the photoproduct of Pp-IX. We has developed a LD pulsed double (635 and 665 nm) laser made by hand as shown in Figure 10. On the CW laser, the longer wavelength laser beam enhanced the PDT effect of tumor in the case of shorter wavelength irradiation at 635 nm only.

Figure 3.

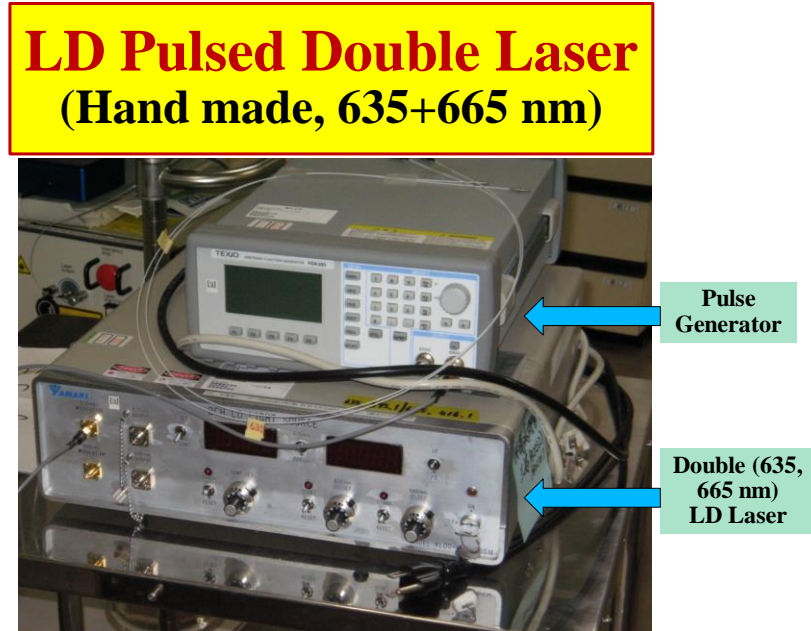
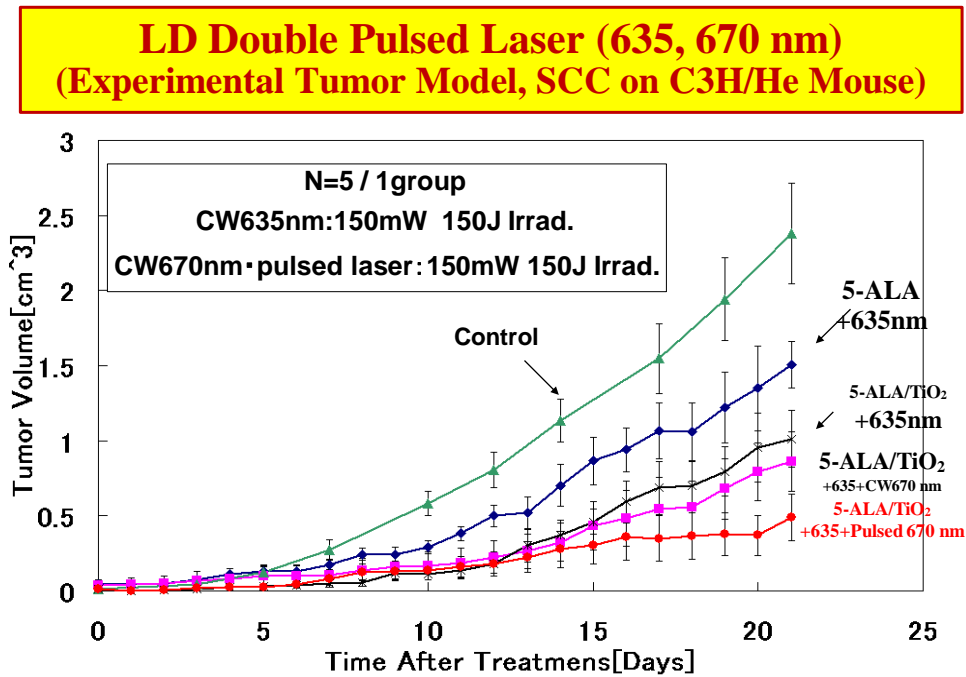


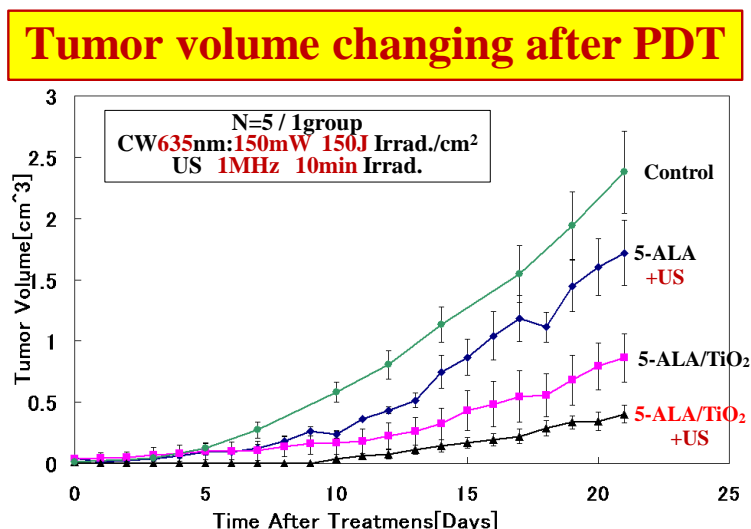
Figure 4.



In the case of using the TiO<sub>2</sub> particles, we have applied the ultrasound irradiation

treatments for the experimental tumor model combined with PDT by the instruments (G:generator, A:amplifier, C:cooling water, and P:ultrasound probe) as shown in Figure 13. As we expected the cavitations effect by ultrasound against the particles, we irradiated the ultrasound (1MHz) for 10 min combined with PDT as shown in Figure 13. It was identified that the enhancing antitumor effects by ultrasound and PDT-combined TiO<sub>2</sub> particles, see Figure 5.

Figure 5.



In future, we are continuing to apply the other combination therapy with PDT against the animal tumor models.

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