Gas sensing using silica high-mesa waveguide

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The desire of mall size health-check system is raised due to the population aging. Compact breath sensor for daily health care may be welcomed because breath test is non-invasive, real time and there are various disease-markers contained in human breath. High-mesa waveguide can be used for gas sensing due to its unique structure that its core can contact to the outside gas, and waveguide can realize compact breath sensing system [1-2]. We have realized CO_2 sensing by using a 4.5cm high-mesa waveguide successfully [3].

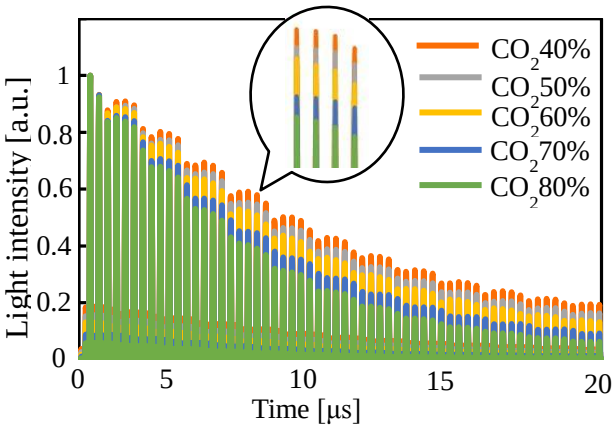

Fig. 1 CO_2 (40-80%) gas sensing results.

Figure 1 shows the CO_2 sensing results from 40% to 80%. As shown in the figure, the light intensity decrease faster while the CO_2 concentration increasing. This figure proves that CO_2 sensing by using silica high-mesa waveguide really happened. CO_2 concentration is estimated by using the difference of the ring-down time [3] between "with CO_2" condition and "Without CO_2" condition. The estimated results and ring-down times are shown in Tab.1. The accuracy of all the cases were within 2%.

Tab. 1 Estimated concentration of CO_2 and ring-down times

Absolute concentration of CO_2 [%]	Estimated result of CO_2 [%]	Ring-down time [μs]	
		Without CO_2	With CO_2
70	70	11.38	9.47
60	58	10.05	8.93
50	51	16.46	14.28
40	39	5.95	5.75

To measure ppm order exhaled gas, a high sensitivity sensing part is necessary. This means a high-mesa waveguide which has low propagation loss and high Γ_{out} (portion light power come out from waveguide) is needed. The silica high-mesa waveguide we using now already has an extremely low loss as 0.02dB/cm, but its largest Γ_{out} is only 3%. To enhance the Γ_{out}, we designed a new waveguide structure. As shown in Fig.2, it's the comparison between the structure we using now and the new structure. The new structure has a very thin core between 50-100nm, it can get a low scattering loss (<0.05dB/cm) and a high Γ_{out} (>20%) at the same time[4].

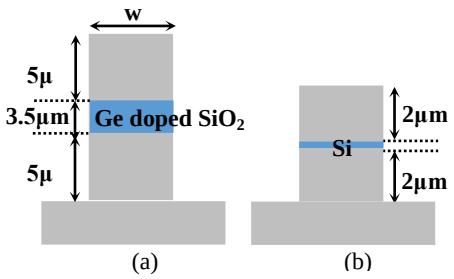

Fig.2 (a) Slica high-mesa waveguide. (b) SOI high-mesa waveguide.

Reference

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[3] H. Hokazono et al., IEICE Electronics Express, Vol. 12, No. 15, pp. 1-8, 201.
[4] C.J. Briker et al, So/-gel science: the physics and chemistry of so/-gel processing, Academic Press, 1990.