Perfectly Tissue-equivalent TLD Phosphor $Li_2B_4O_7(Cu,Pb)$

Noboru Soramasu, Yoshitake Yasuno
Matsushita Industrial Equipment Co. Ltd.
3-3-1, Inazu-cho, Toyonaka, Osaka, 561 Japan

The Lithium-Borate TLD phosphor shows a small sub-response below 80 KeV(1), while other commercially available tissue-equivalent phosphors such as Lithium Fluoride or Beryllium Oxide show an over-response. This indicates the possibility of a perfectly tissue-equivalent Lithium Borate by adding the proper amount of high Z elements.

We investigated several high Z materials including Ag,Sn,Zn,Cr and Pb as well as the method to add these materials to commercial $Li_2B_4O_7(Cu)$. Lead Oxide was found to be effective in adjusting the energy response of $Li_2B_4O_7(Cu)$ without damaging its original TL characteristics. In preparing samples, we first obtained $Li_2B_4O_7(Cu)$ by a sintering method(2), then the sintered phosphor was mixed with PbO and the mixture was heat treated for Pb ions to diffuse.

Figure 1 shows the glow curves of obtained $Li_2B_4O_7(Cu,Pb)$. The shape of the glow curve does not change by adding PbO, however the TL intensity gradually decreases as the amount of PbO increases. Figure 2 shows the distribution of Li. Cu and Pb ions on the surface of a $Li_2B_4O_7(Cu,Pb)$ grain observed by the secondary ion mass spectroscopy. The Pb ions distribute similarly as Cu ions, indicating that Pb ions have replaced Cu ions.

Using the new phosphor, we prepared dosimeters of the commercial structure(3). The $Li_2B_4O_7(Cu,Pb)$ grains of approx. 90μm in diameter were fixed on a plastic film to form a single layer. Figure 3 shows the energy response of the dosimeters placed on phantom. The response below 0.1 MeV increases as the amount of Pb added. The dosimeter using $Li_2B_4O_7(Cu)$ + Pb(0.28%) shows an energy response within ± 3% of the 1 cm deep dose equivalent conversion coefficient curve in the energy range 25KeV and 1.25MeV.

The excellent tissue-equivalence of the phosphor promises better accuracy in medical dosimetry as well as in personal dosimetry.

REFERENCES

1. J.H.Schulman, R.D.Kirk, and E.J.West, Luminescence Dosimetry, U. S. At Energy Comm. Symp. ser. 8. CONF-650637 (1967) p.113.
2 M.Takenaga, O.Yamamoto and T.Yamashita, Nuclear Instruments and Methods 175, p.78 (1980)
3 O.Yamamoto, Y.Yasuno, S.Minamide, S.Hasegawa, H.Tsutsui, M.Takenaga and T.Yamashita, Health Physics 43, p.383 (1982)

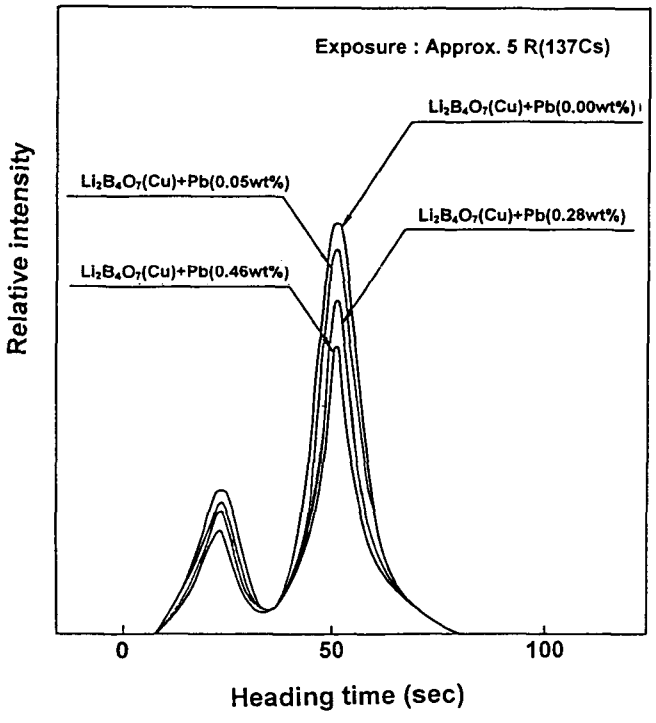

Fig.1 Glow curves of $Li_2B_4O_7$(Cu) added with Pb

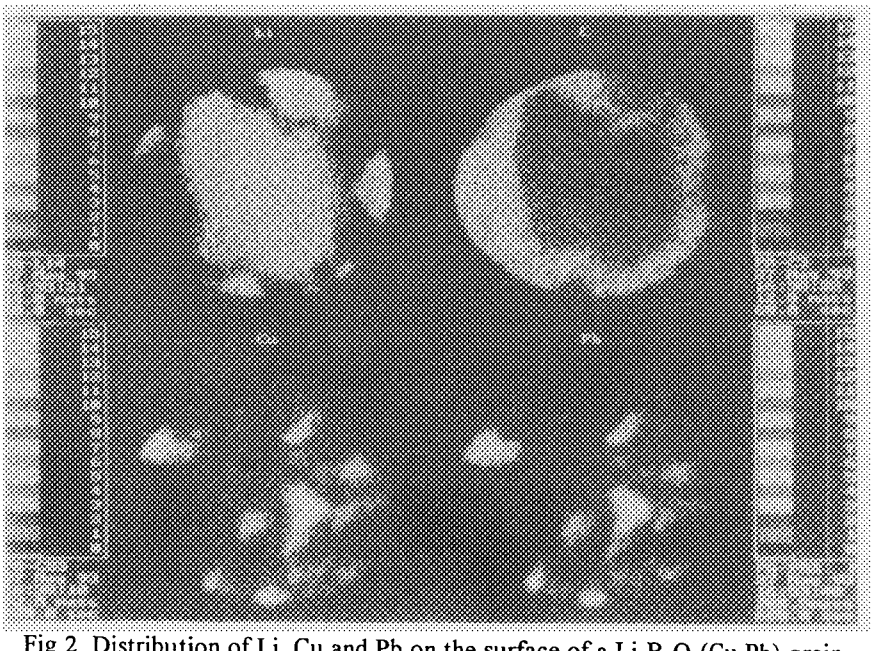

Fig.2 Distribution of Li, Cu and Pb on the surface of a $Li_2B_4O_7$(Cu,Pb) grain observed by secondary ion mass spectroscopy

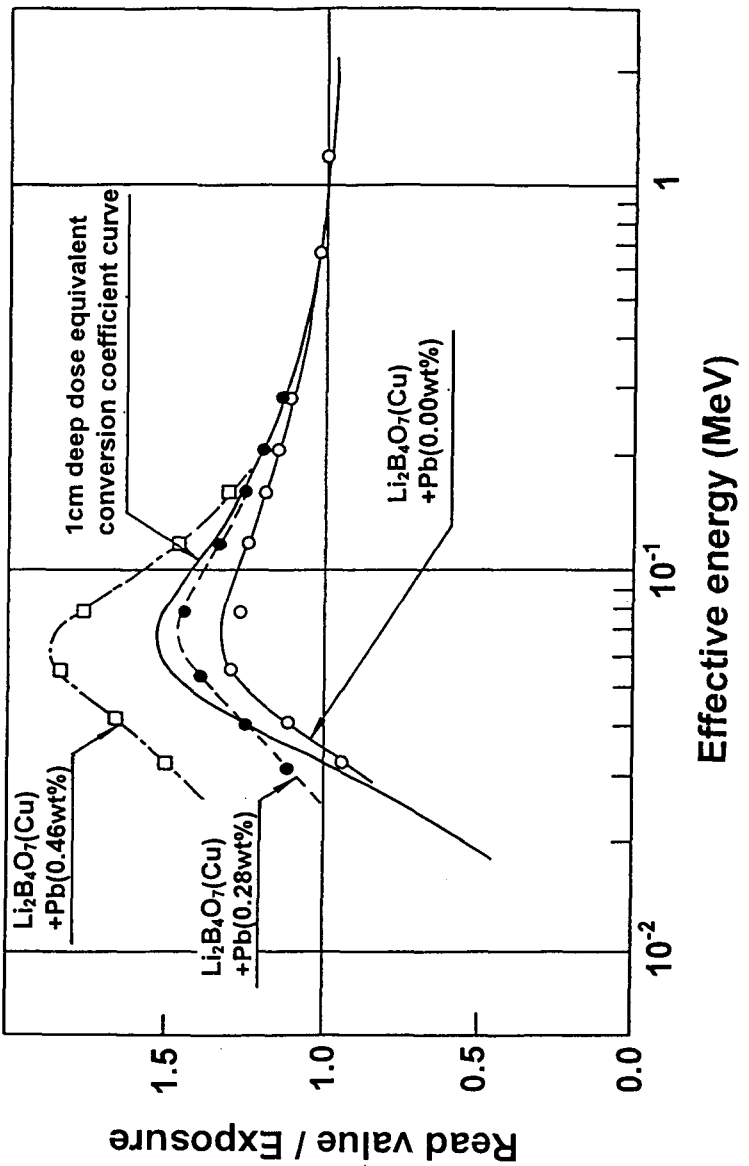

Fig.3 Energy response of $Li_2B_4O_7$(Cu,Pb) TLD located on phantom