Influence of growth conditions on optical, electrical and piezoelectric properties of $Ca_3TaAl_3Si_2O_{14}$ single crystals

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The piezoelectric langasite family ($A_3BC_3D_2O_{14}$) is attracting much attention for high temperature (HT) sensor applications. These crystals do not present any phase transition up to their melting points (1300-1500˚C), exhibit good piezoelectric properties, are non-pyroelectric, and can be grown by the Czochralski (Cz) technique. Among them, the ordered $Ca_3TaAl_3Si_2O_{14}$ (CTAS) is of particular interest, since it is Ga-free, exhibits a high resistivity, and possesses a high thermal stability of dielectric and piezoelectric properties [1]. CTAS single crystals, grown so far with Ir-crucibles, present a yellowish coloration, although according to their bandgap and constituents they should be colorless [2].

In this work, high quality CTAS single crystals were grown with Ir crucible and for the first time also with Pt crucibles by the Cz method (see e.g. Fig.1(a)). The effect of growth conditions on their optical, electrical and piezoelectric properties are determined. All single crystals were visually colorless and no absorption peaks were observed on their transmittance spectra. Figure 1(b) shows the resistivity of CTAS as a function of temperature. The resistivity of CTAS crystals grown under N_2 and N_2+1%O_2 at 400˚C is around 6×10^{10} Ω cm, which is higher than that of CTAS grown under air (1×10^{10} Ω cm) and also than the reported one, especially at HT [1]. The activation energy Ea of the CTAS single crystals in this work is around 1.40 eV, which is smaller than the reported value of 1.64 eV [1].

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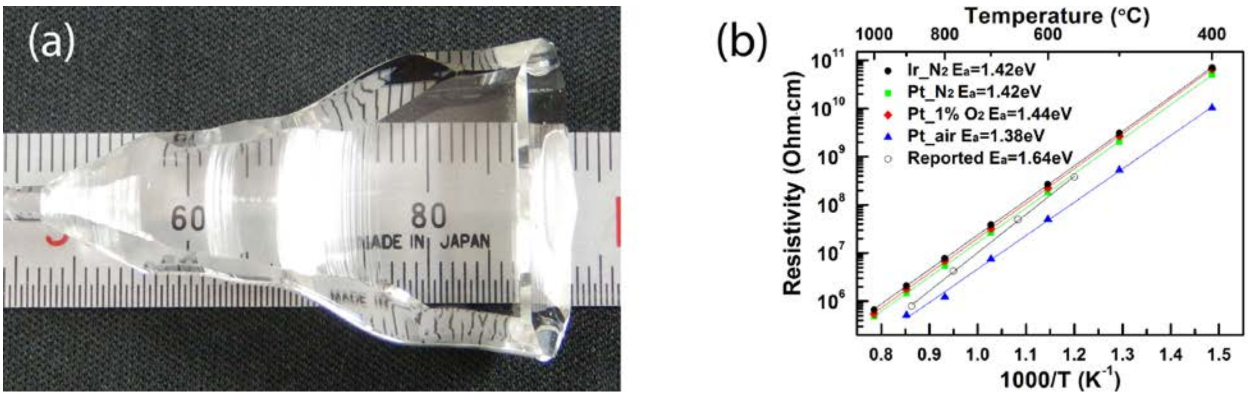

Fig. 1 (a) Photograph of CTAS grown under N_2+1%O_2; (b) Temperature dependence of resistivity.

Reference:

[1] S. J. Zhang, Y. Q. Zheng, H. K. Kong, J. Xin, E. Frantz, and T. R. Shrout, *J. Appl. Phys.*, **105**, 114107 (2009).

[2] J. Xin, Y. Q. Zheng, H. K. Kong, H. Chen, X. N. Tu, and E. W. Shi, *Cryst. Growth Des.*, **8** 2617-2619 (2008).