

Piezoelectric $\text{Ca}_3\text{TaAl}_3\text{Si}_2\text{O}_{14}$ (CTAS) Single Crystals for High Temperature Sensors

NIMS¹, Waseda Univ.², The Univ. Tokyo³, Tokyo Inst. Tech.⁴, [○]Xiuwei Fu^{1,2}, Encarnación G. Vllora¹,

Isao Sakaguchi¹, Yuuki, Kitanaka³, Yuji Noguchi³, Masaru Miyayama³, Kiyoshi Shimamura^{1,2}

and Naoki Ohashi^{1,4}

E-mail: fu.xiuwei@nims.go.jp

The piezoelectric langasite family ($\text{A}_3\text{BC}_3\text{D}_2\text{O}_{14}$) is attracting much attention for high temperature sensor applications. These crystals do not present any phase transition up to their melting points (1300-1500°C), exhibit good piezoelectric properties, are not pyroelectric, and can be grown by the Czochralski (Cz) technique. Among them, the ordered $\text{Ca}_3\text{TaAl}_3\text{Si}_2\text{O}_{14}$ (CTAS) single crystal is of particular interest, since it is Ga-free, and exhibits high resistivity and 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].



Fig.1. Photograph of CTAS grown under $\text{N}_2+1\%\text{O}_2$.

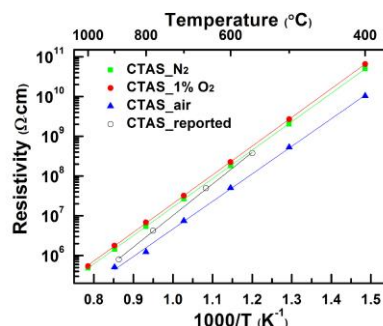


Fig.2. Temperature dependence of resistivity.

In this work, taking advantage of the relatively low melting temperature of CTAS, high quality CTAS single crystals were successfully grown with Pt-crucibles under different atmospheres by the Cz method (see e.g. Fig.1). Independently of growth ambient, all single crystals were visually colorless and no absorption peaks were observed on their transmittance spectra. Figure 2 shows the resistivity of CTAS as a function of temperature. As can be seen, the crystals grown under N_2 and $\text{N}_2+1\%\text{O}_2$ exhibit a significantly higher resistivity compared to the one grown under air, and also the reported one [1]. The piezoelectric coefficients d_{11} were measured to be 4.52, 4.31 and 3.63 pC/N for the CTAS crystals grown under N_2 , $\text{N}_2+1\%\text{O}_2$, and air, respectively. The CTAS grown under nitrogen possesses the highest d_{11} , which is also larger than the reported value of 4.30 pC/N [1].

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References

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