

# Investigation of rotated X-cut $\text{Ca}_3\text{TaGa}_3\text{Si}_2\text{O}_{14}$ single crystals operating in FS mode in the temperature range up to 900°C

Andrey Medvedev<sup>1,2</sup>, Sergey Sakharov<sup>1</sup>, Oleg Buzanov<sup>1</sup>, Vladimir Alenkov<sup>1</sup>,  
Tetsuo Kudo<sup>2</sup>, Yuui Yokota<sup>2</sup>, Kei Kamada<sup>2</sup>, Akira Yoshikawa<sup>2</sup>

<sup>1</sup> OAO «Fomos-Materials», Moscow, Russia

<sup>2</sup> Institute for Material Research, Tohoku University, Japan

Email: medvedev@newpiezo.com

$\text{Ca}_3\text{TaGa}_3\text{Si}_2\text{O}_{14}$  (CTGS) single crystal belongs to 32 point group and possesses a number of unique piezoelectric characteristics. The large magnitude of the piezoelectric modulus  $d_{14}$  and small frequency deviation of thickness shear mode in the wide temperature range (the temperature coefficient of frequency of the second order (TFC<sup>(2)</sup>) is close to  $-63.5 \text{ ppb}/^\circ\text{C}^2$ )<sup>1</sup> enable its application in the development and manufacture of piezoelectric devices operating at high temperature. In this work, the main piezoelectric parameters and frequency versus temperature characteristics (FTC) for rotated X-cuts operating in a face shear mode were investigated.

The orientation of CTGS crystals and cuts notation were made according to the negative value of piezoelectric modulus  $d_{11}$  for right-handed crystals. The plates had square shape and were lapped with  $10\mu\text{m}$   $\text{Al}_2\text{O}_3$ . Ir electrodes were deposited on parallel main faces of the samples. The impedance characteristics of piezoelectric vibrators were measured using Agilent HP 4294A impedance phase-gain analyzer.

The largest coupling factor  $k'_{14}=21.1\%$  was found for (XYt)9°-cut. Fig. 1 shows the deviation of resonance frequency for rotated (XYt)-9° -cut in the temperature range from 25° up to 900°C. It can be seen that the FTC has a departure from a quadratic parabola (dashed curve) which is untypical for langasite family crystals. Fig. 2 gives the variation of the turnover temperature of FTC as a function of rotation angle around X-axis from -20° to 30°. The maximum value of the turnover temperature point  $T=578^\circ\text{C}$  corresponds to (XYt)9°-cut.

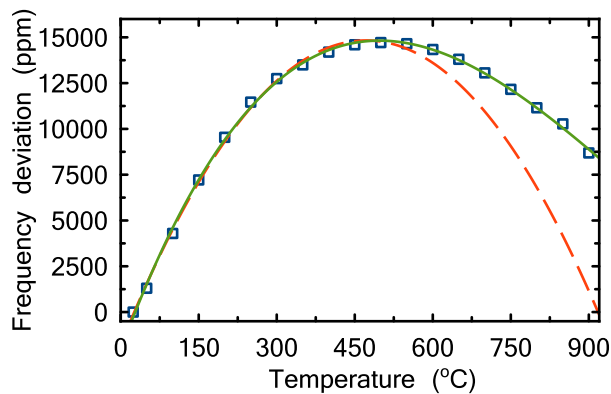


Fig. 1: FTC of (XYt)-9°-cut.

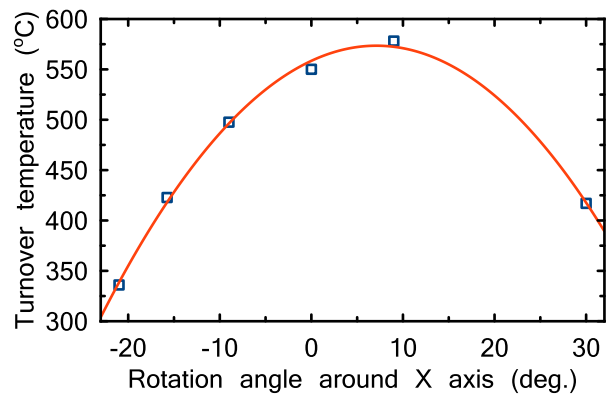


Fig. 2: Turnover temperature as a function of rotation angle around X-axis.

<sup>1</sup> F. Yu, *et al.*, "Investigation of  $\text{Ca}_3\text{TaGa}_3\text{Si}_2\text{O}_{14}$  piezoelectric crystals for high temperature sensor", J. Appl. Phys. 109, 114103, 2011.