Letters to the Editor

SOME PROPERTIES OF SURFACE ACOUSTIC WAVES IN *Z*-CUT ADP*

ANTONI LATUSZEK,** BOHUMIŁ HAŁACIŃSKI,** E. KOTŁICKA,**
Warsaw

НЕКОТОРЫЕ СВОЙСТВА АКУСТИЧЕСКИХ ПОВЕРХНОСТНЫХ ВОЛН В ADP С *Z* СРЕЗОМ

The velocity of surface acoustic waves (SAWs), the electromechanical coupling coefficient and the temperature coefficient of delay on ADP plates of the *Z*-cut were measured at room temperature. For generating SAW interdigital transducers were used.

Production of devices (or their components) based on SAWs claims materials, which meet the demands specified below: a comparatively high electromechanical coupling constant (e.m.c.), the existence of cuts with a small temperature coefficient of delay, availability, a low price etc.

Looking for such materials we have experimentally investigated the properties of SAWs generated in ADP monocrystals ($NH_4H_2PO_4$) of the *Z*-cut. The main physical acoustical properties of this material are described in detail in [1]. It has a great e.m.c. coefficient for the *Z*-cut at $\Phi = 45°$ for volume waves and a great electrooptical coefficient. Heating to temperature of 100 °C causes no damage of the crystal. From the practical point of view it does not absorb water from air until humidity reaches 90 %. It is easy to produce great uniform crystals of ADP from a water solution.

The cost of an ADP plate which is cut for a TV band filter performance is a few orders in magnitude lower than the cost of a similar $LiNbO_3$ plate. The cost of performance of an interdigital transducer on ADP does not exceed the analogical cost for $LiNbO_3$.

In our experiments the deviations of the *Z*-plane from the demanded orientation were kept within the limits ±1°. An apparatus for SAW velocity measurements was the same as that described in [2]. SAWs with $\lambda = 0.1$ mm and 0.2 mm were excited (generated) and detected by broad and interdigital transducers (with a few pairs of fingers).

The generating transducers were excited by voltage pulses of about 0.1 μs, supplied by an ultrasonic flow unit (type 510 — made by UNIPAN).

The same equipment was used as a receiver. At the detection the only difference was that the electric signals from the detecting transducer were passing through an emitter follower/receiver.

The obtained accuracy in velocity measurements was ±2 m/sec (0.1 %). Velocity measurements were based on the comparison of the transition through an investigated surface with the transition times through the quart surfaces where the velocities of SAWs are known ("*ST*" and "*Y*" cuts). The angle Φ which was appointing the direction of SAW has been measured with an accuracy ±0.5° (Fig. 1).

---

* Talk given at 6th Conference on Ultrasonic Methods in Žilina, September 14th—16th, 1978.

** Warsaw Technical University „Politechnika", Institute of Physics, Chodkiewicza 8, PL — WARSAW.

The dependence of the SAW velocity with respect to the angle Φ is plotted in Fig. 2.

The electromechanical coupling factor (constant) has been measured as a relative change in the SAW velocity

$$b = \frac{\Delta V}{V} = \frac{V_1 - V_2}{V_1},$$

where V_1 — velocity of SAWs on a free surface of ADP, V_2 — velocity of SAWs on a surface covered by a thin conducting film.

The constant b has been measured only for the following propagation directions

$$\Phi_1 = 30°, \quad \Phi_2 = 45°, \quad \Phi_3 = 60°$$

and its value is equal to 0.02.

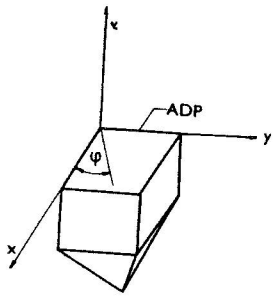

Fig. 1. The way of determination of the angle Φ on the Z surface of ADP crystals

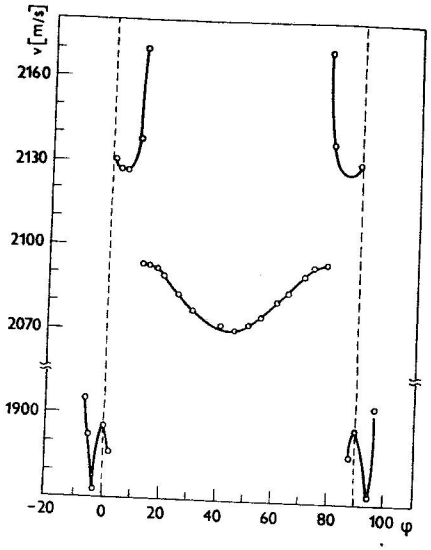

Fig. 2. The dependence of SAWs velocity on the Z surface of ADP versus angle Φ

The outside limit $30° < \Phi < 60°$ of the electron coupling constant reaches lower values and the outside limit $\Phi < 15°$ and $\Phi > 75°$ becomes negligibly small.

For the direction $\Phi = 45°$ the temperature coefficient of delay (t.c.d.) is equal to 340 ppm.

For many applications such a great value of t.c.d. is not admissible.

This is the main reason for which there exists the necessity of looging for planes with a lower value of t.c.d. and a comparatively great e.m.c. coefficient.

A number of SAWs difficult to be identified experimentally appear in the vicinity of two propagation directions, namely at $\Phi \sim 0$ and $\Phi \sim 90°$.

REFERENCES

[1] Mason, W. P.: *Piezoelectric Crystals and Their Application to Ultrasonics.* Academic Press, New York.

[2] Kotlicka, M. E., Łatuszek, A.: *Properties of ultrasonic surface waves in Y-cut TGS.* To be published.

Received October 10th, 1978