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Surface Acoustic Wave (SAW) Devices Based on the Interaction of SAW with Electronics in Semiconductors

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Due to its surface character SAW in piezoelectric material is accompanied by alternating electric field with two components - longitudinal and transverse, perpendicular to the surface, which may be of the same order of magnitude [1] . If SAW propagates along the surface of a piezoelectric semiconductor or piezoelectric dielectric attached to a semiconductor these fields produce bunching of electrons in semiconductor both in longitudinal and transverse directions. The longitudinal bunching, as it is well known [2] , leads to the possibility of the amplification of SAW by supersonic drift of electrons along SAW propagation direction. The transverse bunching leads to strong influence of external transverse electric current on SAW absorption and velocity and even to the possibility of SAW amplification by transverse drift of electrons. Due to this bunching nonlinear acoustoelectronic effects will take place. There will appear two "extrinsic" acoustoelectric currents [1] - usual, longitudinal one, and transverse one, specific only for SAW. These currents will have both d.c. component and component with double frequency and wavenumber. In more general case of two SAW, propagating along the same surface there will exist two additional, "mixed" acoustoelectric currents which have components with sum and difference frequencies and wavevectors. The distribution of electric currents and fields in the semiconductor can be found from the solution of corresponding quasistatic equations [1] .

The d.c. component of the transverse acoustoelectric field, occurs to be highly sensitive to the value of the local conductivity of the semiconductor, so it can be used for "reading" the profile of conductivity of the semiconductor. The amplitude of sum frequency component of transverse acoustoelectric field in the case of two surface acoustic waves is proportional to the convolution of the envelope functions of the waves. All the phenomena pointed out above are highly sensitive to the conditions at the surface of the semiconductor (potential barriers, presence of traps etc.) The interaction of two SAW due to acoustoelectronic nonlinearity may lead to the parametric amplification of one of the waves [3] . Nonlinear interaction of two SAW in the presence of supersonic drift of electrons in semiconductors may lead to a new phenomena - distributed superheterodyne amplification of the waves [4].

Several new acoustoelectronic devices based on these phenomena will be described in this report, including phase shifter, phase modulator, amplitude modulator (by the use of external transverse electric current), acoustoelectric detector, optical image reading device, convolution, correlation and memory devices (using the transverse acoustoelectric effect), mixing frequency device and distributed superheterodyne SAW amplifier etc. The experimental data will be given and the potential advantages of these devices will be discussed.

REFERENCES:

1. Yu.V.Gulyaev, A.Yu.Karabanov, A.M.Kmita, A.V.Medved, Sh.S.Tursunov, Sov.Phys. - Solid State, 12, 2595, 1970 (Russ.Orig.)
2. Yu.V.Gulyaev, V.I.Pustovoit, Sov.Phys. - JETP, 47, 2251, 1964 (Russ.Orig.)
3. J.Zucker, S.Zemon, Journ.Acoust.Soc. of America, 44, 3, 1037, 1971.
4. Yu.V.Gulyaev, P.E.Zilberman, Sov.Phys. - JETP Letters, 11, 421, 1970.