An Analysis of Russian and Worldwide SAW Literature

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Invited Paper

Abstract — The paper is devoted to general analysis of SAW literature (bibliography review). The following questions are considered: (i) The sources of references on SAWs, (ii) A classification of SAW literature, (iii) The temporal dynamics of SAW publications, theses on SAWs and related problems written in Russian, reviews on SAWs.

INTRODUCTION

Everyone who deals with investigations and applications of SAWs in solids comes up against the problem of search for necessary scientific and technical information in the literature. SAWs are investigated in widely diversified fields of science and technics such as seismology, ultrasonic nondestructive testing, acoustoelectronics, acoustooptics, optoacoustics, sensors devices, acoustic microscopy, physical investigations including surface science, surface Brillouin light scattering, fracture of solids, mechanics and mathematics. Owing to this the proper papers on SAWs are scattered in a large number of different journals and other editions. However, none of the sources of references on SAWs including available computer data bases does not contain an exhaustive information on this problem.

The following data which may be of interest both for a beginner and for an expert investigator are presented.

(i) The main sources of references on SAWs such as different abstract journals with indication of sections which may contain SAW references, some reviews and books with vast bibliography and special issues of the journals devoted to SAWs are mentioned.

(ii) A detailed classification of SAW literature is suggested. Some quantitative indices characterizing SAW literature are given.

(iii) Temporal dynamics of SAWs publications is considered. This consideration is concerned in changes of number of SAW articles published in different years, theses written in Russian and devoted to or related with SAWs, and reviews on SAWs.

SEARCH FOR SAW LITERATURE

Besides new computer-based systems for search of information, there are reach possibilities to find SAW papers using traditional information sources. The main of them are listed below with short comments.

Regular sources

1. The most full source of SAW references is annual *Supplement to Journal of Acoustical Society of America* (JASA) entitled "References on Contemporary Papers on Acoustics". There is a special section in this journal 43.35P Surface waves in solids and liquids. This section had the other codes in the first years after its appearance in 1973. The code was 10.15 in 1973. From 1974 till 1976 it was 35.54. Annual supplement to JASA with references was appeared in 1974. In 1973 references were placed in the journal itself, in particularly, in: vol. 53, pp. 990-992, p. 1486, vol. 54, pp. 247-248, pp. 840-841, pp. 1414-1416. In the beginning of 1974 the references were appeared in vol. 56, pp. 243-244. Number of references appeared in this section every year ranges approximately from 200 to 700 (Fig. 1). Unfortunately, a part of references on SAWs is distributed to other sections of this journal. It is

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possible to find some of them using author index, if you know author's name.

2. There is a special abstract journal devoted to only SAWs entitled *Surface Wave Abstracts*. It is published quarterly by Multi-Science Publishing Company Ltd., England. About 200 abstracts of SAW papers are appeared there every year (Fig.1).

3. *Physics Abstracts* published twice monthly by Institute of Electrical Engineers (IEE) and Institute of Electrical and Electronics Engineers, USA, is a very useful source of SAW references. Papers on SAWs may be found in the following sections of this journal (before 1977 there was another classification system).

03.40D Mathematical theory of elasticity

03.40K Waves and waves propagation: general mathematical aspects

43.00 Acoustics

46.30M Vibrations, aeroelasticity, hydroelasticity, mechanical waves and shocks

46.30N Fracture mechanics, fatigue, and cracks

61.70N Grain and twin boundaries

62.00 Mechanical and acoustical properties of condensed matter

68.25 Mechanical and acoustical properties of solid surfaces and interfaces

68.30 Dynamics of solid surfaces and interface vibrations

72.50 Acoustoelectric effects

72.55 Magnetoacoustic effects

75.60C Domain walls and domain structure (magnetic)

75.80 Magnetomechanical and magnetoelectric effects, magnetostriction

77.60 Piezoelectricity and electrostriction

77.80D Domain structure and effects; hysteresis (ferroelectric)

78.20H Piezo-, elasto- and acousto-optical effects

78.35 Brillouin and Rayleigh scattering

81.70 Material testing

81.70C Nondestructive testing

91.30 Seismology

4, 5. The other abstracts journals of physical directivity are *Current Physics Index* published quarterly by the American Institute of Physics (AIP), and *Physics Briefs* published semimonthly by VCH Verlagsgesellschaft mbH, Germany, edited by Deutsche Physikalische Gesellschaft ... & AIP. These journals use AIP classification system slightly different from PACS (Physics Abstracts Classification System). For example, one can find the following sections in the AIP system:

68.35.-p Solid surfaces and solid-solid interfaces

68.35 Gy Mechanical and acoustical properties

68.35 Ja Surface dynamics and interface vibrations

6, 7, 8. Information about papers related with mathematical problems of SAWs is reflected in *Applied Mechanics Review* published monthly by American Society of Mechanical Engineers (the main section for the search is 158. Wave motion in solids, and also in *Mathematical Reviews* published by American Mathematical Society and in *Zentralblatt fuer Mathematik und ihre Grenzgebiete. Mathematics Abstracts* published by Springer International. For two last journals, sections of our interest are:

73.D Wave propagation in and vibrations of solids

73.D20 Surface waves.

9, 10. Papers on SAW devices are annotated, among other journals, in *Electrical and Electronics Abstracts* published by IEE & IEEE (Sect. 28.60 Acoustic wave devices) and in *Engineering Index Annual* published by Engineering Information, Inc., USA (key words for search: acoustic, ultrasonic, ...).

11. Abstracts of various papers on SAWs are appeared in *Chemical Abstract* published by American Chemical Society (search using key words: acoustic, surface acoustic, Rayleigh, ultrasonic, ...).

12, 13. Unusual possibilities of the search are given by *Science Citation Index* (SCI) published by the Institute for Scientific Information (ISI), USA. If any paper of your interest was published some years ago, it is possible to find references of subsequent papers containing references to the paper under consideration using volumes of SCI entitled *Citation Index* and *Source Index* (*Source Index* volumes for determining the titles of the papers). Another edition of ISI entitled *Index to Scientific & Technical Proceedings* is very useful for searching numerous papers on SAWs appeared in proceedings of various scientific and technical meetings.

14. Current information may be obtained from weekly published *Current Contents. Physical, Chemical and Earth Sciences* published by ISI.

15. Some journals on material evaluation including the British Journal of Non-Destructive Testing (NDT) publish regularly references of current papers on ultrasonic NDT.

16. Soviet Union had the information services which tried, as the information services in USA, to annotate literature on all fields and directions of science and technics. There are many Russian abstracts journals of which the following are useful for the search of SAW papers: *RZh Fizika, RZh Radiotekhnika , RZh Elektronika, RZh Mekhanika, RZh Geofizika, RZh Metrologiya.*

Separate sources

Some reviews with vast SAW bibliograpy and collections of SAW bibliography (references with titles of papers)

1. C. K. Campbell, "Application of surface acoustic and shallow bulk acoustic wave devices," Proc. IEEE, vol. 77, pp. 1453-1484, October 1989 (322 ref.).

2. R. M. White, "Surface elastic waves," Proc. IEEE, vol. 58, pp. 1238-1276, August 1970 (245 ref.).

3. A. B. Smith and R. W. Damon, "A Bibliography of Microwave Ultrasonics," IEEE Trans. Sonics Ultrason., vol. SU-17, pp. 86-110, April 1970; sect. Surface Waves, pp. 105-107 (86 ref.).

4. In: *Acoustic Surface Waves and Acousto-Optic Devices.* Ed. by T. Kallard. New York: Optosonic Press, 1971, pp. 171-198 (368 ref.).

5. In: A. J. Slobodnik, Jr., E. D. Conway and R. T. Delmonico, *Microwave Acoustic Handbook, Vol. 1A, Surface Wave Velocities*, Air Force Cambridge Res. Labs., AFCRL-TR-73-0.597, October 1973, pp. 685-713 (576 ref.).

6. In: *Precision Frequency Control, vol. 1. Acoustic Resonators and Filters.* Ed. by E. A. Gerber and A. Ballato. Orlando: Academic Press, 1985.

Some books

7. *Acoustic Surface Waves.* Ed. by A. A. Oliner. Berlin: Springer, 1978.

8. B. A. Auld, *Acoustic Fields and Waves in Solids.* New York: Wiley, vol. 2, 1973.

9. M. K. Balakirev and I. A. Gilinskii, *Waves in Piezoelectric Crystals.* Novosibirsk: Nauka, 1982 (in Russian).

10. S. V. Biryukov, Yu. V. Gulyaev, V. V. Krylov and V. P. Plessky, *Surface Acoustic Waves in Inhomogeneous Media,* Moscow: Nauka, 1991 (in Russian, English translation will be published by Springer).

11. A. Briggs, *Acoustic Microscopy.* New York: Oxford Univ. Press, 1992.

12. C. Campbell, *Surface Acoustic Wave Devices and Their Signal Processing Applications.* San Diego: Academic Press, 1989.

13. S. Datta, *Surface Acoustic Wave Devices.* Englewood Cliffs: Prentice-Hall, 1986.

14. E. Dieulesaint & D. Royer, *Elastic Waves in Solids.* New York: Wiley, 1980.

15. M. Feldmann and J. Henaff, *Surface Acoustic Waves for Signal Processing.* Boston: Artech House, 1989.

16. Garcia-Moliner F. and Velasco V. R. *Theory of Single and Multiple Interfaces.* Singapore, 1992.

17. *Key Papers on Surface Acoustic Wave Passive Interdigital Devices.* Ed. by D. P. Morgan. Stevenage: Peter Peregrinus, 1976.

18. G. S. Kino, *Acoustic Waves: Devices, Imaging and Analog Signal Processing.* Englewood Cliffs: Prentice-Hall, 1987.

19. P. Malischewsky, *Surface Waves and Discontinuities.* Amsterdam: Elsevier, 1987.

20. D. P. Morgan, *Surface-Wave Devices for Signal Processing.* Amsterdam: Elsevier, 1985.

21. V. S. Orlov and V. S. Bondarenko, *Surface Acoustic Wave Filters.* Moscow: Radio i svyaz', 1984 (in Russian).

22. *Rayleigh-Wave Theory and Applications.* Ed. by E. A. Ash and E. G. S. Paige. Berlin: Springer, 1985.

23. *Recent Developments in Surface Acoustic Waves.* Ed. by D. F. Parker & G. A. Maugin. Berlin: Springer, 1988.

24. V. M. Ristic, *Principles of Acoustic Devices.* New York: Wiley, 1983.

25. Surface Phonons. Ed. by W. Kress and F. D. de Wette. Berlin: Springer, 1991.

26. *Surface Wave Filters: Design, Costruction, and Use*. Ed. by H. Matthews. New York: Wiley, 1977.

27. I. A. Viktorov, *Rayleigh and Lamb Waves*. New York: Plenum Press, 1967.

28. I. A. Viktorov, Sound Surface Waves in Solids. Moscow: Nauka, 1981 (in Russian).

29. I. B. Yakovkin and D. V. Petrov, *Light Diffraction by Acoustic Surface Waves*. Novosibirsk: Nauka, 1979 (in Russian).

30. J. Zelenka, *Piezoelectric Resonators and Their Applications*. Amsterdam: Elsevier, 1986.

Special issues of the journals

31. Special Issue on Microwave Acoustics, IEEE Trans. Microwave Theory Tech., vol. MTT- 17, November 1969.

32. Joint Special Issue on Microwave Acoustic Signal Processing, IEEE Trans. Microwave Theory Tech., vol. MTT-21, April 1973 and IEEE Trans. Sonics Ultrason., vol. SU-20, March 1973.

33. Special Issue on Surface Acoustic Wave Devices and Applications, Proc. IEEE, vol. 64, May 1976.

34. Special Issue on Computer Aided Design of SAW Devices, Wave Electronics, vol. 2, July 1976.

35. Joint Special Issue on Surface Acoustic Wave Devices and Applications, IEEE Trans. Microwave Theory Tech., vol. MTT-29, May 1981 and IEEE Trans. Sonics Ultrason., vol. SU-28, May 1981.

36. Special Issue on Acoustic Microscopy, IEEE Trans. Sonics Ultrason., vol. SU-32, May 1985.

37. Special Issue on SAW Convolvers and Correlators, IEEE Trans. Sonics Ultrason., vol. SU-32, September 1985.

38. Special Issue on Acoustic Sensors, IEEE Trans. Ultrason. Ferroelec. Freq. Contr., vol. UFFC-34, March 1987.

39. Special Issue on SAW Applications, IEEE Trans. Ultrason., Ferroelec., Freq. Contr., vol. UFFC-35, November 1988.

CLASSIFICATION OF SAW LITERATURE

General principals and notations

The author of the present paper has gathered a bibliography on SAWs in solids for his scientific work during a long time beginning from 1978. For this he has used various sources including ones desribed above. A classification of SAW literature developed in the process of this work is based on the analysis of available real vast bibliography data and data of numerous scientific publications and so it gives a certain insight into the present state of the investigations of SAWs in the world, although it reflects, of course, also the interests of the present author. The term SAWs is used below, as a rule, in a broad sense in reference to acoustic waves on surfaces of solids. Approximate quantity of the references in this collection is about 15000.

The notations used:

- The heading of the section (N/M),

where N is a total number of papers on a given subject, M is a number of papers published originally in Russian or published in English but written by Russian authors. Notice that practically all Soviet and now Russian scientific journals are translated in English in USA. In calculations of N and M, every paper was taken into account only one time in the most narrow section which corresponds, according to the opinion of the present author, to the main subject of the paper. For example, if any paper is devoted to SAWs in cubic crystals, its reference is not accounted in more general section "Various symmetry classes", since there is a special section "SAWs in cubic crystals". Physical possibilities of the present author to acquaint with a giant quantity of SAW papers are, of course, limited. Therefore, a distribution of a part of papers into the sections is based on the analysis of only their titles. For these reasons all numerical data presented should be considered as approximate and lower estimations of real values. Calculations of N and M performed for first part of the collection of references (see below) give an estimate of a fraction of papers of Russian and Soviet researches in worldwide SAW literature. One can see that the relationship between Russian papers and total number of papers on a given subject depends strongly on the subject (on section of the collection). For the first part of the bibliography which concerns mainly with physical properties of

SAWs, a fracture of Russian SAW papers with respect to worlwide SAW literature is equal to 33 %.

The main headings in the classification are in bold. This classification may be useful also as a possible table of contents or subject index for a detailed handbook on SAWs if anybody will try to write such a book.

The classification

- Reviews on physics of SAWs (132/30)
- **Propagation of SAWs in solids** (mainly isotropic)
- General section, unclassified (96/17)
- Secular equation for Rayleigh waves in isotropic solids (15/1)
- Displacements in SAWs (26/7)
-Three-dimensional SAWs (6/2)
- SAWs of arbitrary form (11/4)
- Power flows in SAWs (46/20)
- Attenuation of SAWs (41/8)
- SAWs in viscoelastic solids (68/15)
- SAWs in solid polymers (5/3)
- SAWs in thermoelastic solids (57/5)
- SAWs in bones (11/8)
- SAWs in wood (3/1)
- SAWs in porous solids (62/18)
- SAWs in granular media (7/2)
- SAWs in micropolar and nonlocal elasticity (83/17)
- Influence of surface tension on SAWs in solids (27/12)
- **Propagation of SAWs in crystals**
- Various symmetry classes (105/20)
- SAWs in cubic crystals (24/8)
- SAWs in transversely isotropic media (25/6)
- SAWs in orthorhombic (orthotropic) media (11/6)
- SAWs in textures and weakly anisotropic solids (34/5)
- Leaky (or pseudo) SAWs in crystals (54/4)
- Normal-mode SAWs in the pseudobranch (10/3)
- One-component SAWs (5/0)
- Exceptional bulk waves (11/8)
- Shallow (or surface skimming) bulk waves (64/23)
- Longitudinal SAWs (17/11)
- SAWs in strongly-anisotropic crystals (27/22)
- **Propagation of SAWs in piezoelectrics**
- Theory of SAW propagation (53/20)
- Electromechanical coupling of SAWs (11/3)
- Piezoelectric materials for SAWs (92/13)
- SAWs in $LiNbO_3$ (38/8)
- SAWs in quartz (22/8)
- SAWs in piezoelectric ceramics (61/7)
- SAWs in $Bi_{12}GeO_{20}$ and $Bi_{12}SiO_{20}$ (11/2)
- SAWs in berlinite (7/0)
- Electromagnetic fields of SAWs in piezoelectrics (22/12)
- Gap SAWs in piezoelectrics and piezomagnetics (23/13)
- SAWs in piezoelectrics covered by metal film (48/3)
- **SAWs in various solids**
- SAWs in amorphous solids (34/1)
- SAWs in ferroelectrics (11/0)
- SAWs in ferroelastics (10/3)
- SAWs in electrostrictive crystals (48/28)
- SAWs at the phase transitions in crystals (34/13)
- SAWs in metals (43/25)
- SAWs in metals in magnetic field (108/58)
- SAWs in magnetic materials (167/79)
- SAWs in superconductors (61/15)
- **SAWs in piezoelectric/semiconductor (P/S) layered structures**
- Different phenomena (61/32)
- Amplification of SAWs in P/S layered structure (81/20)
- Amplification of SAWs in P/S layered structure in magnetic field (9/2)
- Transverse acoustoelectric effect in layered structure and study of semiconductor surface by SAWs (193/75)
- Acoustoresistive effect in layered structure (17/13)
- Second harmonic generation of SAWs in P/S layered structure (21/12)
- Multiwave SAWs interactions in P/S layered structure (7/3)
- Scanning of optical images in layered structures (44/1)
- Acoustoelectric memory in layered structures (67/9)
- SAWs in MOS structures (43/3)
- Interaction of SAWs with diode arrays (44/0)
- Interaction of SAWs with gas plasma and electron beams (38/26)
- Quantum effects for SAWs in P/S layered

structure (11/11)
- Parametric SAW phenomena in P/S layered structure (28/15)
- SAWs in P/S layered structure with periodic electrod array (13/12)
- Multistability in P/S layered structure (16/16)
- **SAWs in piezoelectric semiconductors**
- SAWs in CdS (139/43)
- Transverse acoustoelectric effect in CdS (8/3)
- Amplification of SAWs by transverse field (8/8)
- SAW domains (32/6)
- SAWs in GaAs (137/19)
- Interaction of SAWs and 2D-electron gas (41/17)
- **Propagation of SAWs in different layered systems**
- Isotropic layer on isotropic half-space (59/21)
- Layer on hard half-space (4/4)
- Attenuation of SAWs in absorbing layer on half-space (19/10)
- Rayleigh waves in two-layer system (9/2)
- SAWs in crystalline layers on half-space (40/13)
- SAWs in piezoelectric layered system (50/11)
- ZnO films for SAWs (76/20)
- SiO_2 films for SAWs (15/0)
- SAWs in AlN film on Al_2O_3 (29/8)
- Elastic constants determination of crystals and films by SAWs (29/1)
- SAWs in implanted crystals (42/14)
- Langmuir-Blodgett films for SAWs (17/2)
- Influence of liquid layer on SAWs (44/15)
- Interaction of SAWs and liquid crystals (18/8)
- SAWs in plates
- Waves in layered system solid/liquid/solid
- Channel waves
- SAWs in composites and superlattices
- SAWs in nonregular multilayered systems
- **SAWs in smoothly inhomogeneous media**
- Rayleigh waves
- Love waves
- Perturbation theory
- Numerical calculations
- **Boundary liquid/solid**
- Influence of gas loading on SAWs
- SAWs at the boundary liquid/isotropic solid
- Boundary liquid/crystal
- Reflection of bulk waves from the boundary liquid/surface
- Reflection acoustic microscope
- Line focus acoustic microscope
- **Reflection of bulk waves from the surface in solids**
- Free surface (46/10)
- Energy relations for reflected waves (13/2)
- Interface of two solids
- Reflection in crystals (65/31)
- Reflection in transversely-isotropic solids (20/8)
- Reflection in piezoelectrics (68/51)
- Reflection in piezoelectric semiconductors (44/30)
- Reflection in magnetic medium (31/24)
- Reflection in absorbing media
- **Ferroelectric and ferromagnetic domain walls**
- Reflection of bulk waves from domain boundaries
- Domain ultrasonic trasducer
- Waves guided by domain boundaries
- **Stoneley waves**
- Stoneley waves in isotropic solids
- Stoneley waves in crystals
- Twin and twist boundaries of crystals
- Sliding contact
- Adhesion
- **Lamb waves**
- Lamb waves in isotropic solids
- Rayleigh-Lamb secular equation
- Attenuation of Lamb waves
- Excitation of waveguides by edge load
- Backward-wave transmission
- Reflection in plates
- Edge resonances
- Lamb waves in anisotropic plates
- Lamb waves in piezoelectric plates
- Excitation of Lamb waves in piezoelectic plates
- Lamb waves in piezoelectric semiconductors
- Acoustic charge carrier injection
- Flexural waves in plates
- Longitudinal waves in plates
- Thin plates of crystals
- Thin plates of piezoelectrics
- **Love waves**
- Reflection of Love waves
- Inverse problems for Love waves
- Leaky Love waves
- Love and SH-waves in wedge
- Love waves in double layer system
- Love waves in crystals
- Love waves in piezoelectrics

- Amplification of Love waves in P/S layered structure
- **SH-surface waves**
- Gulyaev-Bleustein waves
- SH-waves on corrugated surfaces
- Magnetoelastic SH-waves
- SH-waves in piezoelectric plates
- SH-waves in bounded piezoelectrics
- **Reflection and transmision of SAWs**
- Vertical plane boundaries
- Defects of surfaces
- Scattering of SAWs by trench
- SAWs at a surface step
- Reflection of SAWs by edge of surface layer
- Acoustic surface shape resonance
- Oblique reflection of SAWs
- SAW waveguides
- Reflection of SAWs from 3D-inhomogenety
- SAWs in laterally inhomogeneous media
- SAWs on rough surfaces
- Roughness-trapped SH-SAWs
- Love waves on rough surfaces
- SAWs on periodic surfaces
- Propagation of SAWs under periodic metal grating on piezoelectrics
- SAW multistrip couplers
- Reflective arrays
- Periodic dot arrays
- SAW resonators
- Transverse modes of SAW resonators and reflectors
- Transformation of surface and bulk waves at periodic surfaces
- Scattering of Rayleigh waves from a surface crack
- Rayleigh waves on faces of a crack
- SAWs and acoustic emission
- Reflection of SAWs from an angle
- Reflection of SAWs from right angle corner
- Wedge waves
- **SAWs on curved surfaces**
- SAWs on sphere
- SAWs on cylinder
- Helical SAWs
- SAWs on concave surface
- SAWs on curved surfaces of crystals
- **SAWs in nonlinear elastic solids**
- Influence of static stresses on SAWs in isotropic solids
- Higher harmonics generation
- Nonlinear SAWs interactions
- Noncollinear interactions
- Interactions of SAWs and bulk waves
- Rectification of acoustic fields
- SH nonlinear SAWs
- Nonlinear reflection
- Nonlinear waves in plates and beams
- **Convolution of SAWs**
- Elastic convolvers
- Elastic convolvers with beam compression
- Convolution of SAWs in P/S layered system
- ZnO/Si SAW convolver
- Transversal-horizontal field convolver
- **Theoretical methods for SAWs**
- Equivalent network analysis for SAWs
- Ray methods for SAWs
- Scalar approximation for SAWs
- Perturbation theory
- Perturbation theory in propagation problems
- Perturbation theory in excitation problems
- Perturbation theory in scattering problems
- Impedance methods for SAWs
- **Experimental methods for SAWs**
- Probes for registration of SAWs
- Field effect transistor detection of SAWs
- Scanning electron microscopy of SAWs
- X-ray topography for SAWs
- Scanning tunneling microscopy of SAWs
- Acoustooptics of SAWs
- **Excitation of SAWs**
- Lamb problem, line source
- Lamb problem, point source
- Lamb problem, moving source
- Polar phase shift
- SAWs and impact of solids
- Anisotropic Lamb problem
- Laser generation of SAWs
- Moving laser sources of SAWs
- Generation of SAWs by Gunn oscillators
- **Diffraction of SAWs**
- Phonon focusing of SAWs
- Diffraction effects in SAW devices
- **Transducers of SAWs**
- Wedge transducers
- "Bridge" (liquid layer coupling) method
- Electrodynamical transducers for SAWs
- Electromagnetic excitation of SAWs in metals

- Edge bonded transducers
- Interdigital transducer (IDT) of SAWs
- Theory of IDT
- Electrical fields of IDT
- Coupling coefficient for IDT
- Equivalent circuit model for IDT
- Gap weighting of IDT
- Removable IDT
- Effects of finite aperture for IDT
- Slanted IDT
- Grating SAW transducer
- Bulk wave generation by IDT
- 2D- periodic IDT
- Thin-film IDT
- Electromechanical coupling constants for layered structures
- IDT at the boundary liquid/solid
- Parametric amplification by IDT
- Nonlinear excitation by IDT
- Van der Pauw's transducer
- **Surface phonons**
- SH SAWs in lattice dynamics
- Lattice dispersion of long-wavelengh SAWs
- Scattering of particles by surface
- Reconstruction of surfaces
- Surface temperature
- Surface specific heat
- Phonons at stepped surfaces
- Reflection of phonons from the boundaries
- Boundary phonons
- Kapitza thermal boundary resistanse
- Surface Brillouin light scattering
- **SAW devices for signal processing**
- Reviews on SAW devices
- Various SAW devices
- SAW filters
- Wideband SAW filters
- Bandpass SAW filters
- Narrowband SAW filters
- Dispersive SAW filters
- Matched SAW filters
- TV SAW filters
- SAW delay lines
- Dispersive SAW delay lines
- SAW frequency synthesizer
- SAW spectrum analysers
- SAW Fourier transformers
- SAW encoders and decoders
- SAW sector-scan devices
- Technology of SAW devices
- Effects of fabrication errors in SAW devices
- Second order effects in SAW devices
- Temperature effects in SAW devices
- Trimming of SAW devices
- Triple-transit signals
- Aging of SAW devices
- **SAW sensor devices**
- SAW strain sensors (of forces, pressure, acceleration)
- Chemical sensors
- Viscosity sensors
- Temperature sensors
- Electric field sensors
- Level monitors
- Touch systems
- Micropositioning using SAWs
- Rotation sensors

GROWTH OF SAW PUBLICATIONS

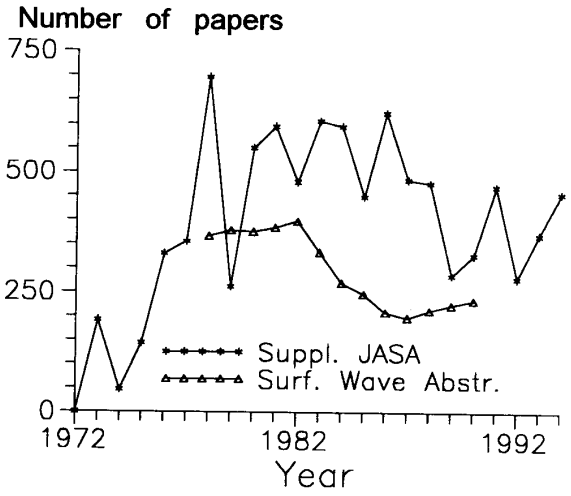

Fig. 1. Number of SAW references appeared every year in sect. Surface waves in Supplement to Journal of Acoustical Society of America and in Surface Wave Abstracts. A total number of references in sect. Surface waves in Suppl. JASA is equal to 9263.

Fig. 2. Number of theses prepeared every year in Russian and devoted to or related with SAWs.

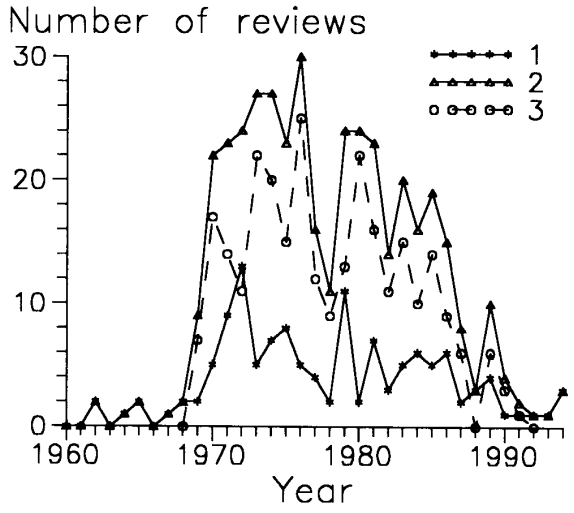

Fig. 3. Number of SAW reviews appeared every year in the world: 1- reviews on SAW physics, 2 - reviews on SAW physics and devices, 3 - reviews on SAW devices. A total number of reviews is no less than 410.

CONCLUSION

Studies and applications of SAWs in solids are very extensive and diversified fields of science and technics at present. This is illustrated by SAW literature classification suggested. The powerful growth of SAW literature in seventies has changed now by a relatively stable and high level of the order of 500 papers published every year in the world. The analysis of literature concerning with physics of SAWs shows that about a third of total quantity of such papers was written by Russian and Soviet researches although this value depends strongly on a subject of a narrow problem under consideration.

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