L 26635-66

ACC NR: AP5025358

A series of such states was found in surface excitons with $E = 0$, $D \neq 0$. Frequency values of surface excitons were determined by the tensor of crystal permittivity taking into account spatial dispersion. Their connection with volume exciton frequencies was established. Orig. art has: 28 equations.

SUB CODE: 20 / SUBM DATE: 04Feb65/ ORIG REF: 005

Card 2/2

L 44319-66 EWT(1)/T IJP(c) GG

ACC NR: AT6015889 SOURCE CODE: UR/3158/65/000/025/0002/0015

78
76
B+1

AUTHORS: Agranovich, V. M.; Ovander, L. N.; Toshich, B. S.

ORG: none

TITLE: On a theory of the nonlinear polarizability of crystals

SOURCE: Obninsk. Fiziko-energeticheskiy institut. Doklady, FEI-25, 1965. K teorii nelineynoy polyarizuyemosti kristallov, 2-15

TOPIC TAGS: tensor, crystal, electromagnetic radiation, Hamiltonian, Green function, Maxwell equation, Fourier series, exciton, phonon interaction, coulomb interaction, nonlinear effect, particle interaction, charged particle

ABSTRACT: The tensor of nonlinear polarizability of crystals ε_{ijl} for the exciton region of the spectrum is found by a method similar to one used earlier (V. M. Agranovich and Yu. V. Konobeyev. FTT, 5, 2524, 1963). The interaction between charged particles of the crystal and the natural radiation field existing in the crystal is not assumed to be weak. The tensor of nonlinear effects is proportional to the corresponding anharmonicity coefficients. The general formula for the tensor of nonlinear polarizability

$$\varepsilon_{ijl}(\vec{x},\omega;\vec{x}',\omega';\vec{x}'',\omega'') = \left(\frac{c^2}{4\pi}\right)^3 \frac{\Delta_{ip}(\vec{x}\omega)\Delta_{nj}(\vec{x}',\omega')\Delta_{nl}(\vec{x}'',\omega'')}{\omega\omega'\omega''} T_{lmn}(\vec{x},\omega;\vec{x}',\omega';\vec{x}'',\omega'')$$

together with

$$T_{lmn}(\vec{x},\omega;\vec{x}',\omega';\vec{x}'',\omega'') = [a_{mln}(-\vec{x}',\vec{x}'';\omega'+i\delta,-\omega''-i\delta) +$$

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L 44319-66

ACC NR: AT6015889

$$+a_{nlm}(-\vec{x}'',\vec{x}';\omega''+i\delta;-\omega'-i\delta)+a_{lmn}(\vec{x},\vec{x}'';-\omega-i\delta;\omega''-i\delta)+$$
$$+a_{lnm}(\vec{x},\vec{x}';-\omega-i\delta;-\omega'-i\delta)+a_{nml}(-\vec{x}'',-\vec{x};\omega''+i\delta;\omega+i\delta)+$$
$$+a_{mnl}(-\vec{x}',-\vec{x};\omega'+i\delta;\omega+i\delta)]\,,$$

permits the tensor of nonlinear effects to be expressed in terms of $\psi_{lmn}(\vec{x},\omega;\vec{x}',\omega')$ and the tensor components $\varepsilon_{ij}(\omega,\vec{x})$. The case of limitingly weak exciton-phonon interaction is examined. The formula for the tensor for the exciton region of the spectrum takes the form

$$\varepsilon_{ijl}(\vec{x},\omega;\vec{x}',\omega';\vec{x}'',\omega'')=\frac{4\pi i N}{V\omega\omega'\omega''}\sum_{\mu_1,\mu_2}\frac{(0|P_i|\vec{x}'\mu_1)(\vec{x}'\mu_1|P_j|\vec{x}\mu_2)(0|P_l|\vec{x}\mu)^*}{[E^{exc}_{\mu_1}(\vec{x}')-\hbar\omega'][E^{exc}_{\mu_2}(\vec{x})-\hbar\omega]}+\ldots .$$

The obtained equations are found to be more suitable than earlier ones in the vicinity of the exciton absorption bands as well as outside the absorption bands if the tensor ε_{ijl} cannot be replaced by δ_{ij}. The authors thank V. L. Ginzburg and L. P. Pitayevskiy for discussion. Orig. art. has: 38 formulas.

SUB CODE: 20/ SUBM DATE: none/ ORIG REF: 013/ OTH REF: 004

Card 2/2 blg

L 29727-66 EWT(1)/T IJP(c) GG

ACC NR: AP6018813 SOURCE CODE: UR/0056/66/050/005/1332/1342

AUTHOR: Agranovich, V. M.; Ovander, L. N.; Toshich, B. S.

ORG: none

46
B

TITLE: Theory of the nonlinear polarizability of crystals

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 50, no. 5, 1966, 1332-1342

TOPIC TAGS: ~~nonlinear optics, polarizability,~~ exciton, POLAR CRYSTAL, TENSOR, CRYSTAL OPTIC PROPERTY, OPTIC SPECTRUM

ABSTRACT: A new method is proposed for calculating the nonlinear crystal polarizability tensor ε_{ijl} (kω, k'ω', k"ω"), which determines the third-order nonlinear optical processes in the exciton spectral range. The main difference between the new method and previous methods is that in determining ε_{ijl}, real electromagnetic waves in a medium are used for the states in the zeroth approximation. The properties of such waves (dispersion law, polarization) differ significantly from those of approximate models, such as Coulomb excitons and transverse photons. A relationship is established between ε_{ijl} and cubic anharmonic coefficients in a normal wave system. The expression for ε_{ijl} obtained by the authors becomes identical to that found by other researchers if the refractive indices of all the normal waves are assumed to be close to unity (or if the tensor ε_{ij} is assumed to be a unit tensor). The new method can also be used for calculating the nonlinear polarizability tensor ε_{ijlm}. Orig. art. has: 38 formulas. [CS]

SUB CODE: 20/ SUBM DATE: 26Nov65/ ORIG REF: 014/ OTH REF: 003/ ATD PRESS: 5013

Card 1/1

ABRAMOVICH, Z. S.

USSR/Mathematics - Hypercomplex

"Hypercomplec Systems Constructed in Accordance with the Sturm-Liouville Equation on the Semiaxis," Yu. M. Berezanskiy, Inst of Math, Acad Sci Ukr SSR

DAN SSSR, Vol 91, No 6, pp 1245-1248, 1953.

Studies rings of summable functions constructed from the Sturm-Liouville eq $y'' = q(t) - \lambda y$ ($0 \leq t \leq \infty$) without any limitations on the order of smallness of q(t) at infinity, but under the assumption that this function is of bounded variation on the semiaxis $(0, \infty)$. This problem was first studied by A. Ya Povzner (Mat Sbor. 23 (65), No 1, 1948) for $q(t) = O(t^{-a-\epsilon})$ (a 2, 3; $\epsilon > 0$) and V. A. Marchenko in his doctoral dissertation (Trudy Moskov Mat Ob-va, Vol 2, No 3, 1953). Cites N. Levinson, Duke Math J. 15, No 1, 1948. Presented by Acad A. N. Kolmogorov 27 June 53.

275T73

AGRANOVICH, Z.S.; POVZNER, A.Ya.; LANDKOF, N.S., otvetstvennyy redaktor; GONCHARENKO, A.P., tekhnicheskiy redaktor

[The application of operational methods to the solution of some problems in mathematical physics] Primenenie operatsionnykh metodov k resheniiu nekotorykh zadach matematicheskoi fiziki. Khar'kov, Izd-vo Khar'kovskogo gos. unv. imeni A.M.Gor'kogo, 1954. 53 p. (MIRA 9:10)

(Calculus, Operational) (Mathematical physics)

SUBJECT USSR/MATHEMATICS/Differential equations CARD 1/2 PG - 737
AUTHOR AGRANOVIČ Z.S., MARČENKO V.A.
TITLE Determination of the potential energy with respect to the dispersion matrix.
PERIODICAL Uspechi mat.Nauk 12, 1, 143-145 (1957)
reviewed 5/1957

Let the system of differential equations

$$(1) \qquad y''_{\alpha} + \lambda^2 y_{\alpha} = \sum_{\beta=1}^{n} v_{\alpha\beta}(x) y_{\beta} \qquad (0 \leq x < \infty;\ \alpha = 1,2,\dots,n)$$

with the real symmetric matrix $v(x) = \| v_{\alpha\beta}(x) \|$, $\int_0^\infty x |v(x)| dx < \infty$ possess the solution matrix $G(x, \lambda)$ which is composed by those solutions for which $y_{\alpha}(0) = 0$ $(\alpha = 1,2,\dots,n)$. For real λ and $x \to \infty$ by the expression $e^{i\lambda x}E - e^{-i\lambda x}S(\lambda)$ the asymptotic behavior of $G(x, \lambda)$ is described, where $S(\lambda)$ is the so-called dispersion matrix.
The authors develop a method for the determination of $v(x)$ for given $S(\lambda)$, given $\mu_k = (i\lambda_k)^2$ and given matrices M_k. These latter describe the asymptotic behavior of those matrices which are formed by eigenvectors which

Uspechi mat.Nauk 12, 1, 143-145 (1957) CARD 2/2 PG - 737

correspond to the eigenvalue μ_k. It is shown that an operator $Kf = f(x) + \int_x^{\infty} K(x,t)f(t)dt$ is existing which transforms every solution $z(x,\lambda)$, being bounded for $x \to \infty$, of the system $z''_{\alpha} + \lambda^2 z_{\alpha} = 0$ $(\alpha = 1,\ldots,n)$ into a solution $y(x,\lambda)$ of (1), where $\lim_{x \to \infty} [y(x,\lambda) - z(x,\lambda)] = 0$. Here $K(x,x) = \frac{1}{2}\int_x^{\infty} v(t)dt$. It is proved that $K(x,y)$ satisfies the linear integral equation

$$(2) \qquad F(x+y) + K(x,y) + \int_x^{\infty} K(x,t)F(t+y)dt = 0,$$

where $F(u) = \sum_k M_k M_k^* e^{-\lambda_k u} + \frac{1}{2\pi}\int_{-\infty}^{+\infty} [E - S(\lambda)]\, e^{i\lambda u}\, d\lambda$.

This equation has a single solution and with the aid of the formula for $K(x,x)$ then $v(x)$ can be determined.

APPROVED FOR RELEASE: 06/05/2000 CIA-RDP86-00513R000100520017-5"

AGRANOVICH, Z.S.

AUTHOR AGRANOVICH Z.S., MARCHENKO V.A. 20-5-1/67

TITLE The Setting Up of the Potential of the Scattering Matrix For a System of Differential Equations.
(Vosstanovleniye potentsiala po matritse rasseyaniya dlya sistemy differentsial'nykh uravneniy -Russian)

PERIODICAL Doklady Akademii Nauk SSSR,1957,Vol 113,Nr 5,pp 951-954 (U.S.S.R.)
Received 6/1957 Reviewed 7/1957

ABSTRACT The present paper deals with the inverse problem of the scattering theory for a system of differential equations of the form $y_\alpha'' + \lambda^2 y_\alpha = \sum_{\beta+1}^{n} v_{\alpha\beta}(x) y_\beta$, $0 < x < \infty$ ($\alpha = 1,2,\ldots n$) (A). The authors here give a direct solution of the problem by making use of a method developed by V.A.MARCHENKO, Dokl.Akad.Nauk.Vol 1o4,Nr 5,p 695(1955). The system A is equivalent to the matrix equation $Y'' + \lambda^2 Y = V(x)Y$. The potential matrix $V(x) = \| v_{\alpha\beta}(x) \|_1^n$ is hermetic and is assumed to satisfy the condition $\int_0^\infty t|V(t)|dt < \infty$. From this condition there follows the integral $\sigma(x) = \int_0^\infty |V(t)|dt$ for any $x > 0$. The following theorem applies: the equation $Y'' + \lambda^2 Y = V(x)Y$ has a solution $E(x,\lambda) = e^{-i\lambda x} I + \int_x^\infty K(x,t) e^{-i\lambda t} dt$ at any λ on the semiplane $\mathrm{Im}\,\lambda \leqslant 0$. Here I denotes the unit matrix, and the matrix K(x,t) satisfies the inequation $|k(x,t)| \leqslant C\sigma((x+t)/2)$ (C=const). Here $2K(x,x) = \int_x^\infty V(t)dt$, $0 < x < \infty$ applies.

Card 1/2

Card 2/2

AUTHOR: Agranovich, Z.A., Marchenko, V.A. 20-118-6-1/43

TITLE: The Construction of the Tensor Forces by the Data of Dispersion (Vosstanovleniye tenzornykh sil po dannym rasseyaniya)

PERIODICAL: Doklady Akademii Nauk, 1958, Vol 118, Nr 6, pp 1055-1058 (USSR)

ABSTRACT: Given the equation

(1) $$Y'' - \left[V(x) + 6x^{-2}P\right] Y + \lambda^2 Y = 0 \qquad (0 < x < \infty),$$

where $P = \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix}$ and $V(x) = \| v_{jk}(x) \|_1^2$ denotes a quadratic Hermitean matrix of second order which for a certain $\varepsilon > 0$ satisfies the condition

(A) $$\int_0^\infty t^{1+\theta} |V(t)| \, dt < \infty \qquad (-\varepsilon < \theta < \varepsilon).$$

Let the boundary condition be

(2) $$Y(0) = 0.$$

Theorem: The boundary value problem (1)-(2) has a continuous spectrum for $\lambda^2 > 0$ and possibly a finite number of non-positive

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eigenvalues $0 \geqslant \lambda_1^2 > \lambda_2^2 > \ldots > \lambda_p^2$. If λ^2 belongs to the spectrum, then there exist solutions $U(x, \lambda)$ of (1) which vanish in $x = 0$ and which generate an equation of Parceval being equivalent to the following decomposition of the δ-function:

$$(3) \qquad \delta(x-y)\cdot I = \sum_{k=1}^{p} U(x,\lambda_k)U^*(y,\lambda_k) + \frac{1}{2\pi}\int_0^\infty U(x,\lambda)U^*(y,\lambda)\,d\lambda .$$

I is the unit matrix, U^* is the matrix conjugate Hermitean to U. The matrices $U(x,\lambda)$ of (3) can be normed such that for $x \to \infty$ there holds

$$U(x,\lambda) \sim e^{i\lambda x}I - e^{i\lambda x}S(-\lambda) \qquad (\lambda^2 > 0)$$

$$U(x,\lambda_k) \sim e^{-|\lambda_k| x}\cdot M_k \qquad (\lambda_k^2 < 0)$$

The dispersion matrix $S(\lambda)$, the eigenvalues and the matrices M_k are denoted as data of dispersion. We have

The Construction of the Tensor Forces by the Data of Dispersion

$$F_1(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} \left[I-S(\lambda)\right] e^{i\lambda t} \, d\lambda,$$ where the elements of the Hermitean matrix $F_1(t)$, $-\infty < t < \infty$ can be represented as sums of two functions, one of which is summable and the other is summable in the square and bounded; for all $t > 0$ there exists $F_1'(t)$ and we have $\int_0^{\infty} t^{1+\theta} \left|F_1'(t)\right| dt < \infty$ $(-\varepsilon < \theta < \varepsilon)$. Besides $S(0)P = P$.

In a further theorem the authors give four necessary and sufficient conditions that a given unitary matrix $S(\lambda)$, the numbers $\lambda_k^2 \leq 0$ and the Hermitean matrices M_k are the data of dispersion of a boundary value problem (1)-(2) with the Hermitean potential $V(x)$ which satisfies (A).

There are 3 references, 1 of which is Soviet, 1 American, 1 English.

PRESENTED: October 9, 1957, by S.N.Bernshteyn, Academician
SUBMITTED: October 9, 1957

PHASE I BOOK EXPLOITATION SOV/5164

Agranovich, Zalman Samoylovich, and Vladimir Aleksandrovich Marchenko

Obratnaya zadacha teorii rasseyaniya (Inverse Problem of the Scatter Theory) Khar'kov, Izd-vo Khar'kovskogo univ., 1960. 267 p. 4,000 copies printed.

Resp. Ed.: N.S. Landkof, Docent; Ed.: A.N. Tret'yakova; Tech. Ed.: A.S. Trofimenko.

PURPOSE: This book is intended for scientists working in the field of mathematics and theoretical physics; it may also be useful to advanced students interested in the spectral theory of differential equations.

COVERAGE: The book deals with one of the new problems in the spectral theory of differential equations - the so-called inverse problem of the quantum theory of scatter. This problem, which has its origin in theoretical physics, is, in the simplest case, reduced to the formation of the differential operator, based on the asymptotic behavior of its normed eigenfunctions at infinity. The book contains a rigorous investigation and solution of the above-mentioned problem. The mathematical apparatus developed for this may also find application in other related problems. Conventionally, problems that indicate which spectral data

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unequivocally determine the differential operator, and present methods for reducing the operator according to these data, have been called "inverse spectral-analysis" problems. The following personalities are mentioned: V.A. Ambartsumyan, V.A. Marchenko, M.G. Kreyn, I.M. Gel'fand, and B.M. Levitan. There are 14 references: 10 Soviet and 4 English.

TABLE OF CONTENTS:

89040
S/044/60/000/009/010/021
C111/C222

16.3500

AUTHOR: Agranovich, Z.S.

TITLE: On the Transformation Operator Generated by a Differential Equation of Second Order and a Condition in Infinity

PERIODICAL: Referativnyy zhurnal. Matematika, 1960, No.9, p.73, Abstract No.10288. Uch.zap.gos.ped.in-ta, 1957, Vol.21, pp.3-8

TEXT: The author proves the following theorem which strengthens a theorem of B.Ya.Levin on the transformation operator (R.zh.Mat, 1957, 423). Let

(1) $$y'' - v(x)y + \lambda^2 y = 0$$

and let hold the condition $\int_0^\infty x|v(x)|dx < \infty$. Then for Im $\lambda \geqslant 0$ there exists a solution of (1) with the form $y(x,\lambda) = e^{i\lambda x} + \int_x^\infty K(x,t)e^{i\lambda t}dt$,

where $\int_x^\infty |K(x,t)|dt < \infty$, $\int_0^\infty \int_x^\infty |K(x,t)|^2 dt\, dx < \infty$.

[Abstracter's note: The above text is a full translation of the original Soviet abstract.]

Card 1/1

37055
S/057/62/032/004/001/017
B125/B108

9.3700

AUTHORS: Agranovich, Z. S., Marchenko, V. A., and Shestopalov, V. P.

TITLE: Diffraction of electromagnetic waves on plane metal gratings

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 32, no. 4, 1962, 381-394

TEXT: The authors have calculated the diffraction of a plane polarized electromagnetic wave incident perpendicularly upon a periodic grating parallel to the x-axis in the XOY plane (E_y, E_z, H_y, H_z = 0). l is the grating constant, d is the gap width. The metal is a perfect conductor. The two special cases of E polarization ($\vec{E}_0 \parallel OX$) and H polarization ($\vec{H}_0 \parallel OX$) can be calculated similarly. The sought electrical field is

$$E_x = e^{-ikz} + \sum_{n=-\infty}^{\infty} a_n e^{i\sqrt{k^2-\left(\frac{2\pi n}{l}\right)^2}\, z}\, e^{\frac{2\pi i n}{l} y} \quad (z>0), \tag{3}$$

above the grating (superposition of the incident and reflected fields) and

$$E_x = \sum_{n=-\infty}^{\infty} b_n e^{-i\sqrt{k^2-\left(\frac{2\pi n}{l}\right)^2}\, z}\, e^{\frac{2\pi i n}{l} y} \quad (z<0), \tag{3'}$$

Card 1/5

below it. The equations

$$\sum_{n=-\infty}^{\infty} b_n e^{in\varphi} = 0, \quad \frac{\pi d}{l} < |\varphi| < \pi, \qquad (7)$$

$$\sum_{n=-\infty}^{\infty} b_n |n| (1-\varepsilon_n) e^{in\varphi} = i\varkappa (b_0 - 1), \quad |\varphi| < \frac{\pi d}{l}. \qquad (7'),$$

with the assumption $\varepsilon_n \rightarrow 0$ for $|n| \rightarrow \infty$, with $b_o = 1 + a_o$; $b_n = a_n$ $(n \neq 0)$ and $\sum_{n=-\infty}^{\infty} b_n e^{(2\pi i n/l)y} = 0$ (on the metal), give with the substitution

$$V_n(\zeta_0) = \frac{1}{\pi i} \int_{L_1} \frac{\zeta^n}{\zeta - \zeta_0} \sqrt{(\zeta - a)(\zeta - \bar{a})}\, d\zeta \quad (\zeta_0 \in L_1),$$

$$V_m^n = \frac{1}{2\pi} \int_{-\pi}^{\pi} V_n(e^{i\varphi}) R(e^{i\varphi}) e^{-im\varphi} d\varphi, \qquad (17),$$

$$R_m = \frac{1}{2\pi} \int_{-\pi}^{\pi} R(e^{i\varphi}) e^{-im\varphi} d\varphi; \quad R_{[0]} = \sum_{m \neq 0} (-1)^m \frac{R_m}{m};$$

the infinite set of equations

$$\left.\begin{aligned} x_m &= i\varkappa b_0 V_m^0 - i\varkappa V_m^0 + \sum_{n\neq 0} x_n \frac{|n|}{n} \varepsilon_n V_m^n + 2cR_m \quad (m\neq 0), \\ 0 &= i\varkappa b_0 V_0^0 - i\varkappa V_0^0 + \sum_{n\neq 0} x_n \frac{|n|}{n} \varepsilon_n V_0^n + 2cR_0, \\ -b_0 &= i\varkappa b_0 V_{[a]}^0 - i\varkappa V_{[a]}^0 + \sum_{n\neq 0} x_n \frac{|n|}{n} \varepsilon_n V_{[a]}^n + 2cR_{[a]}, \end{aligned}\right\} \quad (19)$$

$$x_n = b_n n.$$

for determining b_0, x_m, and b_m, where $x_n = b_n n$. (19) can be solved numerically e.g. by successive approximation if ε is sufficiently small. The authors consider the case in which $0 < \varkappa < 3$ (so that $\varepsilon_{\pm 1}$, $\varepsilon_{\pm 2}$, $\varepsilon_{\pm 3}$ are of the order of unity). In this case, the longwave approximation does not hold any longer, the shortwave one does not yet. (19) gives with $\varepsilon_n = 0$ at every $|n| > N$ a finite set of equations:

$$b_0 = \frac{i\varkappa\Delta}{i\varkappa\Delta + D}; \quad b_n = \frac{x_n}{n} = -\frac{1}{n}\frac{i\varkappa D^{(n)}}{i\varkappa\Delta + D}, \qquad (21) \text{ with}$$

$$\left.\begin{aligned} \Delta &= \Delta_0 + \sum_i \Delta_i\varepsilon_i + \sum_{i<j} \Delta_{ij}\varepsilon_i\varepsilon_j + \sum_{i<j<k} \Delta_{ijk}\varepsilon_i\varepsilon_j\varepsilon_k + \ldots, \\ D &= D_0 + \sum_i D_i\varepsilon_i + \sum_{i<j} D_{ij}\varepsilon_i\varepsilon_j + \sum_{i<j<k} D_{ijk}\varepsilon_i\varepsilon_j\varepsilon_k + \ldots, \\ D^{(n)} &= D_0^{(n)} + \sum_i D_i^{(n)}\varepsilon_i + \sum_{i<j} D_{ij}^{(n)}\varepsilon_i\varepsilon_j + \sum_{i<j<k} D_{ijk}^{(n)}\varepsilon_i\varepsilon_j\varepsilon_k + \ldots, \end{aligned}\right\} \qquad (23).$$

Every ε_i may be a co-factor of first or zeroth degree. D and $D^{(n)}$ are the algebraic complements of the elements $V^{o}_{[\sigma]}$ and $\varepsilon_n\left[V^{n}_{[\sigma]} + V^{-n}_{[\sigma]}\right]$ in the determinant Δ. Formula (21) is the exact solution of the problem if Δ, D, and $D^{(n)}$ are replaced by infinite series following from (23) for $N \to \infty$. The $R_{[\sigma]}$ and $V^{n}_{[\sigma]}$ can be expressed by Legendre polynomials. A. Yu. Titarenko is thanked for calculations and drawings. There are 5 figures and 5 references: 2 Soviet and 3 non-Soviet. The reference to the English-language publication reads as follows: G. L. Baldwin, A. E. Heins, Math. scand., 2, no. 1, 103, 1954.

ASSOCIATION: Fiziko-tekhnicheskiy institut nizkikh temperatur AN USSR (Physicotechnical Institute of Low Temperatures AS UkrSSR) Khar'kovskiy gosudarstvennyy universitet im. A. M. Gor'kogo (Khar'kov State University imeni A. M. Gor'kiy)

SUBMITTED: April 14, 1961

L 18847-65 EWT(d)/EWT(1)/EEC(k)-2/EEC-4/EEC(t)/EPC(b)-2 Pn-4/Pg-4/Pt-10/Pl-4
AEM(c)/ASD(a)-5/AFMD(t)/RAEM(a)/AFWL/AFETR/SSD/ESD(c)/ESD(gs)/ESD(t) WS

ACCESSION NR: AP4049034 S/0057/64/034/011/1950/1961

AUTHOR: Agranovich, Z.S.; Shestopalov, V.P.

TITLE: Propagation of electromagnetic waves in an annular waveguide

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.11, 1964, 1950-1961

B

TOPIC TAGS: electromagnetic wave, electromagnetic wave diffraction, waveguide, waveguide slot, waveguide diffraction, waveguide loss, wave propagation

ABSTRACT: The dispersion equation is derived for the propagation of electromagnetic waves in a system consisting of an infinite number of perfectly conducting thin-walled coaxial circular cylinders of radius A and length L - D separated by gaps of length D. The calculation is performed in cylindrical coordinates r, Φ, z with the z-axis coinciding with the axis of the system. In accordance with Floquet's theorem, the complex electric and magnetic fields are each expressed as the product of a Fourier series in z and an exponential function of z. The coefficients are determined separately for r > A and r < A, so that Maxwell's equations are satisfied and only damped or outgoing waves are present in the region r > A. The effect of the boundary conditions at r = A was calculated by a method previously

described by the authors in collaboration with V.A.Marchenko (ZhTF 32,4,1962). Re-
sults of the earlier paper are merely quoted. This leads to a dispersion equation
in the form of an infinite series, only the first term of which is retained. The
resulting approximate dispersion equation was solved numerically with the aid of
resulting approximate dispersion equation was solved numerically with the aid of
a computer for E-waves and H-waves, and the results are presented graphically.
As the gap increases, the wavelength of the E-waves approaches its free space va-
lue the more rapidly, the longer the wavelength. As the gap decreases, the wave-
length does not at once tend toward its value for a continuous waveguide, but be-
gins to do so only after the gap becomes very small. The H-waves, on the other
hand, do not exhibit this behavior. Under all conditions the H-waves are less
strongly damped than the E-waves. The H-waves are only very slightly damped when
the gaps are narrow, but the damping increases rapidly with gap width for suffici-
ently wide gaps. The width of the gap is more important for H-wave damping than the
number of gaps per wavelength. "In conclusion we express our deep gratitude to V.A.
Marchenko for his creative participation in the discussion of this work. We are al-
so very grateful to L.I.Litvinenko and S.S.Tret'yakova for the great labor they
performed in completing the numerical computations." Orig.art.has: 61 formulas and
7 figures.

L 18847-65

ACCESSION NR: AP4049034

2

ASSOCIATION: Khar'kovskiy gosudarstvenny*y universitet im.A.M.Gor'kogo (Khar'kov State University); Khar'kovskiy institut gornogo mashinostroyeniya, avtomatiki i vy*chislitel'noy tekhniki (Khar'kov Institute of Mining Machinery Construction, Automation and Computer Engineering)

SUBMITTED: 06Feb64 ENCL: 00

SUB CODE: EM NR REF SOV: 002 OTHER: 001

3/3

ACC NR: AR7000893 SOURCE CODE: UR/0058/66/000/009/H035/H035

AUTHOR: Agranovich, Z. S.; Shestopalov, V. P.

TITLE: Dispersion equation of a helical waveguide

SOURCE: Ref. zh. Fizika, Abs. 9Zh252

REF SOURCE: Radiotekhnika. Resp. mezhved. nauchno-tekhn. sb., vyp. 1, 1965, 14-20

TOPIC TAGS: dispersion equation, waveguide, helical waveguide, helical waveguide dispersion equation

ABSTRACT: Wave propagation in a helical waveguide using a strip is theoretically analyzed for the case of an infinitely thin, ideally conductive strip. Field vectors are represented by Fourier series based on Bessel and Hankel functions inside and outside of the waveguide, respectively. Proceeding from the Maxwell equations, the authors write field components inside and outside the waveguide. Superimposition of boundary conditions (the tangential component of vector E is equal to zero, and the radial component of vector H on the strip is continuous, as are the field

Card 1/2

ACC NR: AR7000893

vectors on the slot between the turns of the strip), results in an infinite system of linear, homogeneous algebraic equations. A dispersion equation is derived by equating the determinant of this system to zero. The presence in the terms of the determinant of factors tending to zero with an increase in the ordinal number of the term makes it possible to limit the consideration of the determinant to a determinant of a finite order. A modification of the dispersion equation for the case of space resonance is cited. [Translation of abstract] [DW]

SUB CODE: 20, 09/

Card 2/2

AGRANOVSKA, I.

"Recorded on magnetic tape." Vol. 3, No. 5/6, 1954, p. 18. Radio, Sofiya

SO: Eastern European Accessions List, Vol. 3, No. 11, Nov. 1954, L.C.

AGRANOVSKAYA, A. I.

(3) Chem

Nuclear Science Abstracts
Vol. 7
November 1953
Mineralogy, Metallurgy and Ceramics

FERROELECTRIC PROPERTIES OF $BaTiO_3$-$PbZrO_3$ SOLID SOLUTIONS. G. A. Smolenskii /Smolensky/ A. I. Agranovskaya, and N. N. Krainik. Translated from Doklady Akad. Nauk S.S.S.R. 91, 55-8 (1953). 5p. (NSF - tr - 81; D - 91 -55)

$BaTiO_3$-$PbZrO_3$ solid solutions were prepared by pressing finely powdered $BaTiO_3$ and $PbZrO_3$ and baking at 1150 to 1450° for one hr. in an atmosphere of PbO. The variation of the dielectric constant in weak fields and the relative change in length with temperature were graphed. The dependence of the Curie temperature of solid solutions of $BaTiO_3$-$PbZrO_3$ on the concentration of $PbZrO_3$ in the solution was determined and graphed. (J.S.R.)

11-9-54
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Inst. of Silicate Chemistry, AS USSR

62

USSR.

Development of spontaneous polarization in lead stannate and lead tantalate. G. A. Smolenskii and A. I. Agranovskaya. *Doklady Akad. Nauk S.S.S.R.* 97, 237-(1954).—The dielec. const. of Pb stannate was detd. by S. (*Zhur. Tekh. Fiz.* 22, 8(1952)) as not greater than 20. The Pb stannate samples were made with the addn. of ZrO_2 and TiO_2 (2-3%) and were heated at a comparatively low temp. The x-ray diffraction patterns of such samples were shown by P. Z. Tandur to have, besides a series of other lines, the lines of perovskite (the mineral $CaTiO_3$). Lead stannate without addns. has a noncubic structure and decomp. at 964° (Colleen, *C.A.* 47, 8981*f*). Now, partially crystd. samples of Pb stannate having the perovskite type of structure were obtained by adding 5-10 mol. % of Ba stannate, and these samples had a max. dielec. const. of about 144 at 150 degrees, and a power loss tangent, low up to about 180° but rising abruptly to over 11 at 280°. It was then suspected that the compds. MNb_2O_6 and MTa_2O_6 might also develop spontaneous polarization. The dielec. const. for Pb tantalate is 800 at 255° and about 480 at room temp. and 410 at 390°. The power loss tangent is of the same nature as for the stannate. The elec. measurements were made in weak fields at a frequency of 10^4 cycles. Goodman (*C.A.* 48, 969*a*) has shown that Pb titanate has a much higher Curie temp. than does Ba titanate despite the smaller ionic radius of Pb compared with that of Ba ion. V. H. G.

Seignettoelectric properties of solid solutions: (Pb, Ba)SnO_3, Pb(Ti, Sn)O_3, and Pb(Zr, Sn)O_3. G. A. Smolenskii, A. I. Agranovskaya, A. M. Kalinina, and T. M. Fedotova. [illegible] 25, 2134-42(1955).—The dielec. permeability and the dissipation factor were measured from 0 to 300°. In addn. the temps. of phase transitions for the various compds. as a function of compn. were detd. The results show that the solid soln. (Ba, Pb)SnO_3 (I) crystallizes with a perovskite structure and possesses seignettoelec. properties. These solns. differ from other seignettoelec. compds. in that the central atom does not have the at. structure of a noble gas. The transition temp. of I decreases as the $BaSnO_3$ content increases. The solid solns. Pb(Ti, Sn)O_3 and Pb(Zr, Sn)O_3 (II) shows high transition temps. if the percentage of $PbSnO_3$ is high. In II two phase transitions were discovered. Werner Jacobson

The [illegible]

AGRANOVSKAYA, A.I.

USSR/Electricity - Dielectrics G-2

Abs Jour : Ref Zhur - Fizika, No 3, 1957, No 6964

Author : Smolenskiy, G.A., Agranovskaya, A.I.

Title : Dielectric Constant of Cerates of Divalent Metals.

Orig Pub : Zh. tekhn. fiziki, 1956, 26, No 2, 484-485

Abstract : A measurement was made of the dielectric and of its temperature coefficient in the range 20 -- 80° at frequency 10^6 cycles in sintered specimens of cerates of barium, strontium and calcium. For $BaCeO_3$, $\varepsilon = 28$, and $(\Delta\varepsilon/\varepsilon)\Delta t = 180 \times 10^{-6}$; for $SrCeO_3$, $\varepsilon = 27$, and $(\Delta\varepsilon/\varepsilon)\Delta t = 40 \times 10^{-6}$. The porosity of $BaCeO_3$ and $SrCeO_3$ after final annealing (1 hour at 1350°) was 2 -- 4%. It was impossible to obtain a cerate of calcium.

Card : 1/1

AGRANOVSKAYA, A. I.

USSR/Electricity - Semiconductors G-3

Abs Jour : Referat Zhur - Fizika, No 5, 1957, 12136

Author : Smolenskiy, G.A., Isupov, V.A., Agranovskaya, A.I.

Inst : - .

Title : High Dielectric Constant of Niobates and Tantalates of Divalent Metals.

Orig Pub : Dokl. AN SSSR, 1956, 108, No 2, 232-235

Abstract : An investigation was made of the dielectric properties of niobates and tantalates of Ca, Cd, Sr, Pb, and Ba. To prepare the specimens, finely ground initial materials were pressed and fired. The resultant material was again powdered, pressed, and subjected to final firing. Measurements were made of ε , tan δ , and of the dependence of ε on the temperature T of the resultant polycrystalline specimens. The investigated materials have high values of ε with a negative temperature coefficient (TK_{ε}). A positive TK_{ε} is observed only by the

Card 1/2

AGRANOVSKAYA, A. I.

57-11-15/33

AUTHORS: Smolenskiy, G. A., Isupov, V. A., Agranovskaya, A. I., Sholokhova, Ye. D.

TITLE: Non-Seignette-Electrical Phase Transition in Solid Solution in $(Ca,Sr)(Ti,Zr)O_3$ and $Na(Nb,Ta)O_3$ Systems (Nesegnetoelektricheskiye fazovyye perekhody v tverdykh rastvorakh, obrazuyushchikhsya v sistemakh $(Ca,Sr)(Ti,Zr)O_3$ i $Na(Nb,Ta)O_3$).

PERIODICAL: Zhurnal Tekhn. Fiz., 1957, Vol. 27, Nr 11, pp.2528-2534 (USSR)

ABSTRACT: The purpose of this work was to explain the character of these phase transitions. Based on the experiments as well as on the explanations given you can say that in solid $(Ca,Sr)(Ti,Zr)O_3$ - solutions and especially in solid $(Ca,Sr)(Ti,O_3)$-solutions ordinary crystallographic transitions take place and that,neither calcium-titanate nor the mentioned solid solutions are anti-seignette-electrics. The authors are of opinion that in natrium-niobate at 480° and 640°C as well as in natrium-tantalate at 475°C, and in consequence of this also in solid $Na(Nb,Ta)O_3$ -solutions ordinary crystallographic transitions take place. Actually the phase transitions at 480° and 640° in natrium-niobate displace into the range of lower temperatures in the case of a substitution of a natrium ion, smaller according to its measurements,by the greater potassium ion. The authors conclude that natrium-tantalate is not a seignette-electric. There are 7 figures and

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Non-Seignette-Electrical Phase Transition in Solid Solution in $(Ca,Sr)(Ti,Zr)O_3$ and $Na(Nb,Ta)O_3$ Systems. 57-11-15/33

2 tables.

ASSOCIATION: Institute for Semiconductors AN USSR, Leningrad (Institut poluprovodnikov AN SSSR, Leningrad)

SUBMITTED: April 8, 1957

AVAILABLE: Library of Congress

Card 2/2

AGRANOVSKAYA

PA - 3047

AUTHOR SMOLENSKIY G.A., ISUPOV V.A., AGRANOVSKAYA A.I.,

TITLE Phase Transitions in Seignette-Electric Solid Solutions on the Basis of Strontium Pyro Tantalate.
(Fazovyye perekhody v segnetoelektricheskikh tverdykh rastvorakh na osnove pirotantalata strontsiya -Russian)

PERIODICAL Doklady Akademii Nauk SSSR, 1957, Vol 113, Nr 4, pp 803-805 (U.S.S.R.)
Received 6/1957 Reviewed 7/1957

ABSTRACT The solid solutions of the seignette electrica of this type investigated up to now are enumerated in short. The present paper investigates other solid solutions of seignette-electric niobates and tantalates and gives some data on the solid solutions in the following systems : $Sr_2Ta_2O_7$ + $Sr_2Nb_2O_7$, $Sr_2Ta_2O_7$ + $Ba_2Ta_2O_7$ and $Sr_2Ta_2O_7$ + $Ca_2Ta_2O_7$. Hitherto the sample have not been investigated radiographically, but the distinct shifting of CURIE's temperature is indicative of the creation of solid solutions in alimited concentration interval. The samples were produced according to the usual ceramic method and were annealed for one hour at a temperature of 1480°C. An increase of the CURIE temperature of the solid solutions of $Sr_2(Ta,Nb)_2O_7$ was expected on the occasion of the replacement of Ta-ions by Nb-ions. The present paper confirms this expectation, as may be seen from the attached diagrams of the temperature dependence of the dielectricity constant of the solid solutions in the system $Sr_2Ta_2O_7$+$Sr_2Nb_2O_7$. The CURIE temperature increased by about 32° on the occasion of an increase of

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AUTHOR	SMOLENSKIY G.A., ISUPOV V.A., AGRANOVSKAYA A.I.,	PA - 3c22
TITLE	The Solid Solutions of Metaniobate and Metatantalate of Barium in Barium-Titanate which Have Seignette-Electric Properties. (Tverdyye rastvory metaniobata i metatantalata bariya v titanate bariya, obladayushchiye segnetoelektricheskimi svoystvami -Russian)	
PERIODICAL	Doklady Akademii Nauk SSSR, 1957, Vol 113, Nr 5, pp 1053-1056 (U.S.S.R.) Received 6/1957	Reviewed 7/1957

ABSTRACT The authors investigated various compound systems $BaTiO_3$ - $Ba_{0,5}NbO_3$ and $BaTiO_3$ - $Ba_{0,5}TaO_3$ with a content (of up to 10 mol.-percent) of $Ba_{0,5}NbO_3$ and $Ba_{0,5}TaO_3$. The polycrystalline samples with a low degree of open porosity were produced in the usual manner. The introduction of barium-metaniobate into the barium titanate modifies the temperature dependence of ε and tg δ considerably. With a content of 1 mol.-$^0/_0$ $Ba_{0,5}NbO_3$ the ε - peak vanishes at Curie point and there remains only a salient point in the curve $\varepsilon = f(T)$. If the $Ba_{0,5}NbO_3$ content increases, this salient point becomes less pronounced, and with more than 5 mol-$^0/_0$ $Ba_{0,5}NbO_3$ it vanishes entirely. In soild solutions a maximum of ε is found to exist in the domain of the phase transition from the tetragonal to the orthorhombic structure. If the concentration of bariumβmetaniobate increases, the maxima of the curves $\varepsilon = f(T)$ weaker and more washed out, on which occasion they shift towards lower temperatures. The position of the maxima and of the salient points of the curve $\varepsilon = f(T)$ does not depend on frequency in solid solutions.

Card 1/2 In solid solutions with a high content of barium metaniobate tg δ chan...

APPROVED FOR RELEASE: 06/05/2000 CIA-RDP86-00513R000100520017-5"

The Solid Solution of Metaniobate and Metatantalate of Barium PA - 3082
in Barium-Titanate which Have Seignette-Electric Properties.

only slightly if temperature drops below 110 - 120°. Analogous regular developments are found in the system $BaTiO_3 - Ba_{0,5}TaO_3$, but barium metatantalate is less "effective" than barium metaniobate. From the temperature dependence of the dielectricity constant the points of the phase transitions were determined and a diagram of the phase transitions from the cubic phase into the tetragonal phase and from the tetragonal into the orthorhombic phase was constructed. In the systems $BaTiO_3 - BaNbO_{3,5}(BaTaO_{3,5})$ the barium pyroniobate and the barium pyrotantalate exercise a similar effect as barium metaniobate and barium metatantalate. The comparatively slight dependence of the dielectricity constant of the investigated solid solutions on temperature and on the field strength, the lack of volatile components, as well as the low burning temperature make it appear probable that these solid solutions can be put to technical use.
(with 3 illustrations)

ASSOCIATION Institute for Semiconductors of the Academy of Science of the U.S.S.R.
PRESENTED BY IOFFE A.F., Member of the Academy
SUBMITTED 31.7.1956
AVAILABLE Library of Congress
Card 2/2

AGRANOVSKAYA, A. I.

Smolenskiy, G. A., V.A. Isupov, A. I. Agranovskaya and Ye. D. Sholokhova, Leningrad, Institut khimii silikatov AN SSR (Institute for Silicate Chemistry, AS USSR) "Polarization and Dielectric Losses in Several Solid Solutions of the First and Second Classes"

(The Physics of Dielectrics; Transactions of the All-Union Conference on the Physics of Dielectrics) Moscow, Izd-vo AN SSSR, 1958. 245 p. 3,000 copies printed.

This volume publishes reports presented at the All-Union Conference on the Physics of Dielectrics, held in Dnepropetrovsk in August 1956, sponsored by the "Physics of Dielectrics" Laboratory of the Fizicheskiy institut imeni Lebedeva An SSSR (Physics Institute imeni Lebedev of the AS USSR), and the Electrophysics Department of the Dnepropetrovskiy gosudarstvennyy universitet (Dnepropetrovsk State University).

AGRANOVSKAYA, A. I.

48-22-3-2/30

AUTHORS: Smolenskiy, G.A., Isupov, V.A., Agranovskaya, A. I., Sholokhova, Ye. D.

TITLE: Polarization and Dielectric Losses in Some Solid Solutions of the First and Second Type. (Polyarizatsiya i dielektricheskiye poteri v nekotorykh tverdykh rastvorakh pervogo i vtorogo roda) Theses of the Lecture. The Complete Article is Published in ZhTF, 1957, Nr 27, p. 2528 and DAN USSR, 1957, Nr 113, pp. 803 and 1053 (Tezisy doklada. Podrobnaya stat'ya opublikovana v ZhTF, Nr 27, p. 2528, 1957, DAN SSSR, Nr 113, pp. 803, 1053 (1957)

PERIODICAL: Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya, 1958, Vol. 22, Nr 3, p. 236 (USSR)

ABSTRACT: 1) The results obtained by the investigation of the polarization and the dielectric losses of polycrystalline samples of some solid solutions of the first and second type are given in the lecture.
2) The results obtained by the investigation of the systems of solid solutions (Sr, Ca)(Ti, Zr)O_3 are given.

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48-22-3-2/30

Polarization and Dielectric Losses in Some Solid Solutions of the First and Second Type. Theses of the Lecture. The Complete Article is Published in ZhTF, 1957, Nr 27, p. 2528 and DAN USSR, 1957, Nr 113, pp. 803 and 1053

3) The system of the solid solutions $BaTiO_3$——$LaAlO_3$ was investigated.
4) Solid solutions of the first type: $(Sr, Ca)_2Ta_2O_7$, $(Sr, Ba)_2Ta_2O_7$, $Sr_2(Ta, Nb)_2O_7$ were investigated on the basis of strontium-pyrotantalate.
5) The results obtained by the provisional investigation of the solid solutions of the second type are given: $BaTiO_3$——$BaTa_2O_6$ and $BaTiO_3$——$BaNb_2O_6$.

ASSOCIATION: Institut khimii silikatov Akademii nauk SSSR (Institute of the Chemistry of Silicates, AS USSR)

1. Crystals--Polarization 2. Alloys--Dielectric properties

Card 2/2

AUTHORS: Smolenskiy, G. A., Agranovskaya, A. I. SOV/57-28-7-21/35

TITLE: Dielectric Polarization and Losses of Some Complex Compounds (Dielektricheskaya polyarizatsiya i poteri nekotorykh soyedineniy slozhnogo sostava)

PERIODICAL: Zhurnal tekhnicheskoy fiziki, 1958, Vol. 28, Nr 7, pp. 1491 - 1493 (USSR)

ABSTRACT: The authors investigate by the example of oxygen compounds with perovskite structures the possibility of obtaining compounds of complex composition. In this case the general formula reads: $(A_1, \dots, A_k)(B_1, \dots, B_l)O_3$. The conditions necessary for the ions A_i and B_i are written down. Considering that the ions tend to a certain coordinate number it may be assumed that the possibility of the formation of a number of compounds $(A_1, A_2)(B_1, B_2)O_3$ with perovskite structure is not impossible. In an analogous way also the possibility of the formation of solid solutions of compounds with complex composition and perovskite structure, as well as of compounds and solid solutions of other structures can be investigated. A number of such compounds and solid so-

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Dielectric Polarization and Losses of Some Complex Compounds SOV/57-28-7-21/35

lutions were synthetically investigated on this basis. It was shown that of the investigated compositions with perovskite structure $Pb_3(NiNb_2)O_9$ and $Pb_3(MgNb_2)O_9$ have a high dielectric constant. $Pb_3MgNb_2O_9$ is a ferroelectric substance with a Curie temperature of -10°C. The high dielectric constant of $Pb_3NiNb_2O_9$ is dependent on the relaxation mechanism of polarization. It is possible that the relaxation mechanism in $Pb_3NiNb_2O_9$ and in some other compounds and their solid solutions does not depend on ion processes but on electron processes. It is assumed that a ferro-electric phase transition exists in the "relaxators" at sufficiently low temperatures. The difference in the mechanisms of dielectric polarization in the compounds $Pb_3MgNb_2O_9$ and $Pb_3NiNb_2O_9$ in the investigated temperature interval proves the important role played by the structure of the electron shells of the ions and the character of the chemical binding. Thus a ferroelectric substance with complex composition was discovered for the first time. The authors show ways for searching ferro-

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Dielectric Polarization and Losses of Some Complex Compounds SOV/57-28-7-21/35

electrics, and moreover of compounds of complex composition as well as of solid solutions with interesting electric and magnetic properties. R.A.Zvinchuk assisted in this work and supervised the determination of the lattice parameters of elementary cells of the investigated compounds.
It could not be found which of the formulae was correct, that with or that without brackets. One of them must be a misprint.
There are 1 figure, 1 table, and 1 Soviet reference.

ASSOCIATION: Institut poluprovodnikov AN SSSR Leningrad (Institute for Semiconductors, AS USSR, Leningrad)

SUBMITTED: January 7, 1958

1. Complex ions--Polarographic analysis

Card 3/3

24(6) SOV/57-28-10-8/40

AUTHORS: Smolenskiy, G. A., Agranovskaya, A. I., Popov, S. N., Isupov, V. A.

TITLE: New Ferroelectric Substances of a Complex Composition (Novyye segnetoelektriki slozhnogo sostava)
II. $Pb_2Fe^{3+}NbO_6$ and Pb_2YbNbO_6 (II. $Pb_2Fe^{3+}NbO_6$ i Pb_2YbNbO_6)

PERIODICAL: Zhurnal tekhnicheskoy fiziki, Vol 28, Nr 10, pp 2152-2153 (USSR) 1958

ABSTRACT: This paper covers an account of the synthetic production of polycrystalline samples of $Pb_2Fe^{3+}NbO_6$ and Pb_2YbNbO_6. They were synthetized by a reaction in solid phase according to conventional powder-metallurgical methods. The Pb_2FeNbO_6 samples were sintered at 950°C, the Pb_2YbNbO_6 at 900°C. It was established by X-ray structural analyses that the compounds produced have a perovskite-structure, the niobium-, ytterbium-, and iron ions occupying octahedric positions. The dielectric constant of Pb_2FeNbO_6 samples passes through a maximum at 112°C. Pronounced dielectric hysteresis loops are found at room temperature. Hence

Card 1/2

New Ferroelectric Substances of a Complex Composition, SOV/57-28-10-8/40
II. $Pb_2Fe^{3+}NbO_6$ and Pb_2YbNbO_6

$Pb_2Fe^{3+}NbO_6$ is a ferroelectric substance. The maximum of the dielectric constant of Pb_2YbNbO_6, which is small, is found at a much higher value, at 280°C. The curve $\varepsilon = f(T)$ exhibits a kink near 240°C. tg δ equals 0.03 at room temperature and a frequency of 1 kcy. It quickly increases at heating, passing through a not very deep minimum at about 240°C, and increasing again henceforth. The dielectric constant versus temperature function typical of antiferroelectric substances, the absence of a hysteresis loop and the sufficiently small geometric criterion t ($t \simeq 0.93$) substantiate the assumption that Pb_2YbNbO_6 is an antiferroelectric substance. There are 1 figure and 7 references, 2 of which are Soviet.

SUBMITTED: May 8, 1958

Card 2/2

New Ferroelectric Substances of a Complex Composition SOV/57-28-10-8/40
II. $Pb_2Fe^{3+}NbO_6$ and Pb_2YbNbO_6

Card 3/3

SMOLENSKIY, G.A.; AGRANOVSKAYA, A.I.; POPOV, S.N.

Polarization mechanism in $Pb_3NiNb_2O_9$-$Pb_3MgNb_2O_9$ solid solutions. Fiz.tver.tela 1 no.1:167-168 Ja '59. (MIRA 12:4)
(Solutions, Solid) (Polarization (Electricity))

SMOLENSKIY, G.A.; ISUPOV, V.A.; AGRANOVSKAYA, A.I.

New group of seignettoelectrics with a laminated structure. Fiz. tver.tela 1 no.1:169-170 Ja '59. (MIRA 12:4)
(Ferroelectric substances)

SMOLENSKIY, G.A.; ISUPOV, V.A.; AGRANOVSKAYA, A.I.

New seignettoelectics of complex composition of the type $A_2^{+2}(B_I^{+3}B_{II}^{+5})O_6$ Part 1. Fiz.tver.tela 1 no.1:170-171 Ja '59. (MIRA 12:4)
(Ferroelectric substances)
$(A_2^{+2}(B_I^{+3}B_{II}^{+5})O_6)$

SMOLENSKIY, G.A.; ISUPOV, V.A.; AGRANOVSKAYA, A.I.

Seignettoelectric properties of solid solutions in the system $PbNb_2O_6$ - $BaNb_2O_6$ - $SrNb_2O_6$. Fiz. tver. tela 1 no.3:442-449 Mr '59. (MIRA 12:5)

1. Institut poluprovodnikov AN SSSR, Leningrad.
(Solutions, Solid) (Curie point) (Ferroelectric substances)

SMOLENSKIY, G.A.; ISUPOV, V.A.; AGRANOVSKAYA, A.I.

Dielectric polarization of solid solutions in the system (Ba,Sr) $Ta,Nb)_2O_6$. Je '59. (MIRA 12:10)

1. Institut poluprovodnikov AN SSSR, Leningrad.
(Solutions, Solid--Electric properties)

SMOLENSKIY, G.A.; AGRANOVSKAYA, A.I.; ISUPOV, V.A.

New seignettoelectrics of complex composition. Part 3: Pb_2MgWO_6; $Pb_3Fe_2WO_9$, Pb_2FeTaO_6. Fiz. tver. tela 1 no.6:990-992 Je '59. (MIRA 12:10)

1. Institut poluprovodnikov Akademii nauk SSSR, Leningrad. (Ferroelectric substances)

66336
SOV/181-1-10-11/21

~~24(6)~~ 24.7800

AUTHORS: Smolenskiy, G. A., Agranovskaya, A. I.

TITLE: Dielectric Polarization of a Number of Compounds of Complex Composition

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 10, pp 1562 - 1572 (USSR)

ABSTRACT: The ε- and tgδ-values were measured at room temperature and 1 kilocycle by the usual methods for a number of polycrystalline, synthetic complex compounds. The results obtained for 19 samples (such as $Ba(Ta, Al)O_3$, $Ba(Nb_{0.5}, Al_{0.5})O_3$, $Pb(Ta, Al)O_3$, $Ba(Ni,Nb)O_3$, etc) are given in table 4. Table 3 contains the exact composition of the various samples, the preliminary and final annealing temperature and annealing time. 8 of these samples belong to the perovskite minerals. The structure of one sample was indicated by I. G. Ismail-zade. Further results of measurement are shown in diagrams: the temperature dependence of the ε- and tgδ-values of $Pb_3(Mg,Nb_2)O_9$ at 1 kilocycle (Fig 1); the ε- and tgδ-values

4

Card 1/3

4

66336

Dielectric Polarization of a Number of Compounds of Complex Composition SOV/181-1-10-11/21

of this investigation were published at the II All-Union Conference on Ferroelectricity held at Rostov-na-Donu in 1957. There are 5 figures, 4 tables, and 11 references, 6 of which are Soviet.

ASSOCIATION: Institut poluprovodnikov AN SSSR, Leningrad (Institute for Semiconductors of the AS USSR, Leningrad)

SUBMITTED: August 4, 1958

Card 3/3

66337

~~24(6)~~ 24.7900

SOV/181-1-10-12/21

AUTHORS: Smolenskiy, G. A., Isupov, V. A., Agranovskaya, A. I.

TITLE: Ferroelectric Solid Solutions of Substitution With Subtraction

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 10, pp 1573 - 1582 (USSR)

ABSTRACT: In order to complement publications by many Western authors and the Soviet scientists Skanavi and Ksendzov, the authors studied the ferroelectric properties of the following systems: $BaTiO_3$-$Ba_{0.5}NbO_3$; $BaTiO_3$-$Ba_{0.5}TaO_3$;$BaTiO_3$-$La_{2/3}TiO_3$;$BaTiO_3$--BaO:NiO; $BaTiO_3$-WO_3; $BaTiO_3$-BaO:$AlO_{1.5}$; $BaTiO_3$-$NaTiO_{2.5}$. The samples were prepared by the usual ceramic methods. For burning temperatures of the samples see table 1. The temperature dependence of the ε- and tgδ-values for the individual systems is graphically illustrated in figures 1,2,4, 5, 6 and 10. Figure 3 shows the temperature dependence of phase transformations occurring in the solid solutions of the systems $BaTiO_3$-$La_{2/3}TiO_3$ and $BaTiO_3$-$LaAlO_3$. The temperature dependence

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Ferroelectric Solid Solutions of Substitution With Subtraction SOV/181-1-10-12/21

of the specific elongation of the solid solutions of $BaTiO_3$-$Ba_{0.5}$-NbO_3 is depicted in figure 8. Figure 7 represents the dielectric hysteresis loops of the solid solution of the system $BaTiO_3$-$Ba_{0.5}NbO_3$ as dependent on the $BaNbO_3$ content. Figure 9: temperature dependence of the dielectric constant of the solid solutions of the system $BaTiO_3$-$Ba_{0.5}NbO_3$ as dependent on the $Ba_{0.5}NbO_3$ concentration. Final digest: 1) The ferroelectric solid solutions of substitution with subtraction may be divided into two groups: a) In the first group the maximum of the dielectric constant at the Curie point is retained even if the solid solution contains a high percentage of the second component. b) The maximum of the dielectric constant of the second group is suppressed already by a small percentage of the second component. The first group includes the solid solutions of $La_{2/3}TiO_3$ in $BaTiO_3$, whereas the solid solutions of $Ba_{0.5}NbO_3$, $Ba_{0.5}TaO_3$, and BaO:NiO in $BaTiO_3$ belong to the second group. 2) The properties

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66337

Ferroelectric Solid Solutions of Substitution With Subtraction SOV/181-1-10-12/21

of the solid solutions (second group) of substitution with subtraction may be explained by the perturbing effect of electrons and holes located near the vacancies of the crystal lattice. The first report on this investigation was delivered at the All-Union Conference on Ferroelectricity held at Rostov-na-Donu in 1957. The Soviet scientists Yu. N. Venevtsev, A. F. Ioffe, Devyatkova, and Stil'bans are quoted in this article. There are 10 figures, 1 table, and 9 references, 4 of which are Soviet.

ASSOCIATION: Institut poluprovodnikov AN SSSR, Leningrad (Institute for Semiconductors of the AS USSR, Leningrad) 4

SUBMITTED: August 18, 1958

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AGRANOVSKAYA, A.I.

PHASE I BOOK EXPLOITATION SOV/4379

Vsesoyuznaya konferentsiya po fizike dielektrikov. 2d, 1958

Fizika dielektrikov; trudy vtoroy vsesoyuznoy konferentsii (Physics of Dielectrics, Transactions of the 2d All-Union Conference on the Physics of Dielectrics) Moscow, Izd-vo AN SSSR, 1960. 532 p. Errata slip inserted. 5,000 copies printed.

Sponsoring Agency: Akademiya nauk SSSR. Fizicheskiy institut imeni P.N. Lebedeva.

Ed. of Publishing House: Ye.L. Starokadomskaya; Tech. Ed.: I.N. Dorokhina. Editorial Board: (Resp. Ed.) G.I. Skanavi, Doctor of Physics and Mathematics (Deceased), and K.V. Filippova, Candidate of Physics and Mathematics.

PURPOSE: This collection of reports is intended for scientists investigating the physics of dielectrics.

COVERAGE: The Second All-Union Conference on the Physics of Dielectrics held in Moscow at the Fizicheskiy institut imeni P.N. Lebedeva (Physics Institute imeni P.N. Lebedev) in November 1958 was attended by representatives of the principal scientific centers of the USSR and of several other countries. This collection contains most of the reports presented at the conference and summaries of the discussions which followed. The reports in this collection deal with dielectric properties, losses, and polarization, and with specific inductive capacitance of various crystals, chemical compounds, and ceramics. Photoelectrets, ferroelectric crystals, and various radiation and irradiation effects on dielectrics are investigated. The volume contains a list of other papers presented at the conference dealing with polarization, losses, and breakdowns of dielectrics, which were published in the Journal Izvestiya AN SSSR, seriya fizicheskaya, No. 2, 1960. No personalities are mentioned. References accompany each report.

18

APPROVED FOR RELEASE: 06/05/2000 CIA-RDP86-00513R000100520017-5"

88695

S/058/60/000/010/004/014
A001/A001

9.4300 (and 1043, 1155)

Translation from: Referativnyy zhurnal, Fizika, 1960, No. 10, p.254, # 27014

AUTHORS: Smolenskiy, G.A., Agranovskaya, A.I., Sholokhova, Ye.D.

TITLE: Ferroelectric Properties of Solid $BaTiO_3$-$LaAlO_3$ Solutions

PERIODICAL: Fiz. sb. L'vovsk. un-t, 1959, No. 2 (7), pp. 101 - 106

TEXT: Ferroelectric properties of solid solutions in the $BaTiO_3$-$LaAlO_3$ system were investigated. In this system solid solutions are formed with the structure of perovskite, possessing ferroelectric properties at the high content of barium titanate. The Curie point and dielectric constant in the peak of solid solutions are sharply decreasing with an increase in the content of lanthanum aluminate. No spontaneous polarization occurs in lanthanum aluminate and in solid solutions containing more than 16 molar % $LaAlO_3$. These experimental data corroborate the viewpoint that central ions in ferroelectrics must have the structure of inert gases after losing s- and d-electrons, i.e., must form from atoms with the

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S/058/60/000/010/004/014
A001/A001

Ferroelectric Properties of Solid $BaTiO_3$-$LaAlO_3$ Solutions

incomplete penultimate electron shell. Solid solutions containing 10 - 12.5 molar % $LaAlO_3$ are characterized by the sloping temperature relations of ε, which is explained by the fluctuation of composition in solid solutions.

Authors' conclusions

Translator's note: This is the full translation of the original Russian abstract.

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S/181/60/002/01/17/035
B008/B014

24.7800

AUTHORS: Kraynik, N. N., Agranovskaya, A. I.

TITLE: Antipiezoelectric and Piezoelectric Properties of Some Solid Solutions Containing Pb_2MgWO_6

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 1, pp. 70-72

TEXT: The authors synthesized samples of $PbMg_{1/2}W_{1/2}O_3$ and some solid solutions in the systems $PbMg_{1/2}W_{1/2}O_3$-$PbTiO_3$ and $PbMg_{1/2}W_{1/2}O_3$-$PbMg_{1/3}Nb_{2/3}O_3$ and studied their dielectric properties. The synthesis was carried out according to the usual ceramic technology, but the final annealing was performed in PbO vapors. The X-ray phase analysis of numerous samples of the system $PbMg_{1/2}W_{1/2}O_3$-$PbTiO_3$ has shown that these samples have a perovskite structure. There was no sign of a second phase. Fig. 1 shows the temperature dependence of ε of a number of solid solutions of the last-mentioned system, which was measured at 1000 cps. Samples with less than 10% of $PbTiO_3$, which were located in fields of up

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Antipiezoelectric and Piezoelectric Properties of Some Solid Solutions Containing Pb_2MgWO_6

S/181/60/002/01/17/035
B008/B014

to 20 ev/cm, showed no hysteresis, whereas hysteresis loops below the temperature of the ε-maximum were observed in samples having more than 10% of $PbTiO_3$. These hysteresis loops vanished, however, as soon as the temperature exceeded this point. Thus, the piezoelectric phase is formed within the concentration range of ~ 10% $PbTiO_3$, the temperatures of the ε-maxima corresponding to the Curie points. When the content of $PbTiO_3$ is raised up to 10%, the Curie temperature drops considerably (Fig. 2). When the content of $PbTiO_3$ is further increased, the Curie temperature starts rising. It passes through a minimum also in the system $PbMg_{1/2}W_{1/2}O_3$-$PbMg_{1/3}Nb_{2/3}O_3$. Samples with less than 20% of $PbMg_{1/3}Nb_{2/3}O_3$ showed no hysteresis loops. Above 20%, there are so-called "double" hysteresis loops. This confirms the assumption that $PbMg_{1/2}W_{1/2}O_3$ is an antipiezoelectric material. On the strength of the experiments carried out, it may be classified as an extremely "hard" antipiezoelectric

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Antipiezoelectric and Piezoelectric Properties of Some Solid Solutions Containing Pb_2MgWO_6

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material. In spite of the similarity of the structure factors which were calculated with the aid of ionic radii, the compound $PbMg_{1/2}W_{1/2}O_3$ is an antipiezoelectric material and $PbMg_{1/3}Nb_{2/3}O_3$ is a piezoelectric. The parameters of the elementary cells of these compounds show great differences. The authors thank Professor G. A. Smolenskiy for discussing the results obtained here. There are 2 figures and 5 references, 4 of which are Soviet.

ASSOCIATION: Institut poluprovodnikov AN SSSR, Leningrad (Institute of Semiconductors, AS USSR, Leningrad)

SUBMITTED: May 11, 1959

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APPROVED FOR RELEASE: 06/05/2000 CIA-RDP86-00513R000100520017-5"

86444

S/181/60/002/011/032/042
B006/B060

24.7800 (1035,1142,1162)

AUTHORS: Smolenskiy, G. A., Isupov, V. A., Agranovskaya, A. I., and Popov, S. N.

TITLE: Ferroelectrics With Blurred Phase Transitions

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 11, pp. 2906-2918

TEXT: This is the reproduction of a lecture delivered at the All-Union Conference on Ferroelectricity which took place in Moscow in January, 1960. A report was made on studies conducted on polycrystalline specimens of ferroelectrics with blurred phase transition and belonging to the two systems $Pb(Mg_{1/3}Nb_{2/3})O_3$ - $Pb(Ni_{1/3}Nb_{2/3})O_3$ and $Ba(Nb, Ta)_2O_6$ - $Sr(Nb,Ta)_2O_6$. These ferroelectrics exhibit a relaxation polarization in the region of phase transition. The technique of the specimen preparation has already been described by A. I. Agranovskaya (Ref. 6), and the method of measurement in Ref. 2. Investigation results are illustrated in diagrams and are discussed in great detail. Fig. 1 shows ε and $\tan\delta$ as functions of temperature for $Pb(Ni_{1/3}Nb_{2/3})O_3$ in weak fields at frequencies between 1 and

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Ferroelectrics With Blurred Phase Transitions S/181/60/002/011/032/042
B006/B060

1500 kc. Both curve groups exhibit a maximum between -150 and -100°C, the precise position and height of which is somewhat frequency-dependent. The maximum loss angle is the larger the higher the frequency. Fig. 2 shows the temperature dependence of ε and $\tan\delta$ on $Pb(Mg_{1/3}Nb_{2/3})O_3$ in weak fields at frequencies between 0.4 and 4500 kc. This compound as well exhibits loss angle maxima, lying between -50 and 0°C and which are the higher, the higher the frequency. The ε-maxima (between 9000 and 12000) are the higher, the lower the frequency. At 0.4, 1, and 45 kc they still lie at negative temperatures, but already at positive ones at 450, 1500, and 4500 kc. The ascending part of the $\varepsilon(t)$ curves is frequency dependent, but not so the dropping part. Figs. 3 and 4 show oscillograms of the hysteresis loops of these two compounds at -90 and -196°C, respectively, taken at varying electric field strengths (E_{max} = 20 kv/cm and 60 kv/cm). Fig. 5 shows the temperature dependence of total polarization on $Pb(Mg_{1/3}Nb_{2/3})O_3$, $Pb(Ni_{1/3}Nb_{2/3})O_3$, and solid solutions $xPb(Mg_{1/3}Nb_{2/3})O_3 + (1-x)Pb(Ni_{1/3}Nb_{2/3})O_3$, the x-values being given near the curves. Fig. 6 shows, for these specimens, the spontaneous polarization as a temperature function, Fig. 7 the temperature dependence of the resonance frequencies of radial vibrations, of the elasticity and piezoelectric modulus, and Fig. 8 the temperature dependence of the linear expansion coefficient. Fig. 9 again shows ε and tan δ as a temperature function for the solid solutions (like Fig. 5), the numbers near the curves again denoting x. Fig. 10 illustrates the relative change in the specimen lengths (solid solutions) as a temperature function for different x and Fig. 11 ε and tan δ as a function of temperature for solid $Ba_{0.5}Sr_{0.5}(Nb_xTa_{1-x})_2O_6$ solutions. Fig. 13 shows the same for $Ba(Ti_{0.7}Sn_{0.3})O_3$. It is concluded from the results obtained that the blurred phase transitions observable in a large group of ferroelectrics can be explained by the submicro-inhomogeneous structure of these substances. The relaxation polarization is believed to be due to a shift of the domain boundaries in weak fields. G. A. Skanavi, V. A. Bokov, I. Ye. Myl'nikova, S. M. Ariya, V. Ya. Fritsberg, E. Zh. Freydenfel'd, and Ya.Ya. Kruchan are mentioned. There are 13 figures and 16 Soviet references.

ASSOCIATION: Institut poluprovodnikov AN SSSR Leningrad (Institute of Semiconductors of the AS USSR, Leningrad)

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Ferroelectrics With Blurred Phase Transitions S/181/60/002/011/032/042
B006/B060

SUBMITTED: July 13, 1960

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B006/B060

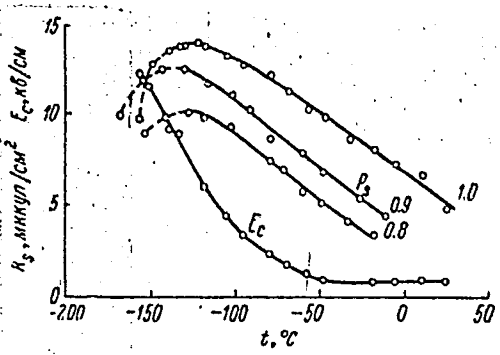

Рис. 6. Температурная зависимость спонтанной поляризации $Pb(Mg_{1/3}Nb_{2/3})O_3$ и твердых растворов $xPb(Mg_{1/3}Nb_{2/3})O_3 + (1-x)Pb(Ni_{1/3}Nb_{2/3})O_3$, а также коэрцитивной силы $Pb(Mg_{1/3}Nb_{2/3})O_3$ (E_c).

Цифры на кривых указывают величину x.

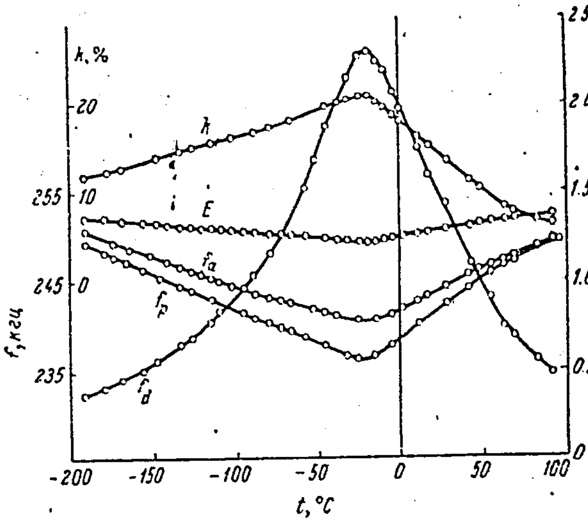

Рис. 7. Температурная зависимость резонансных частот радиальных колебаний f_a и f_p, модуля упругости E, пьезомодуля $|d_{31}|$ и коэффициента электромеханической связи k образца PbMg при $E = 15$ кв/см.

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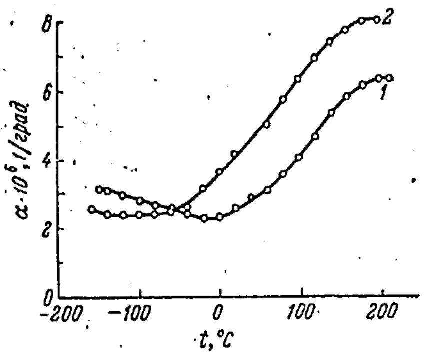

Рис. 8. Температурная зависимость коэффициента линейного расширения образцов $Pb(Mg_{1/3}Nb_{2/3})O_3$ (1) и $Pb(Ni_{1/3}Nb_{2/3})O_3$ (2).

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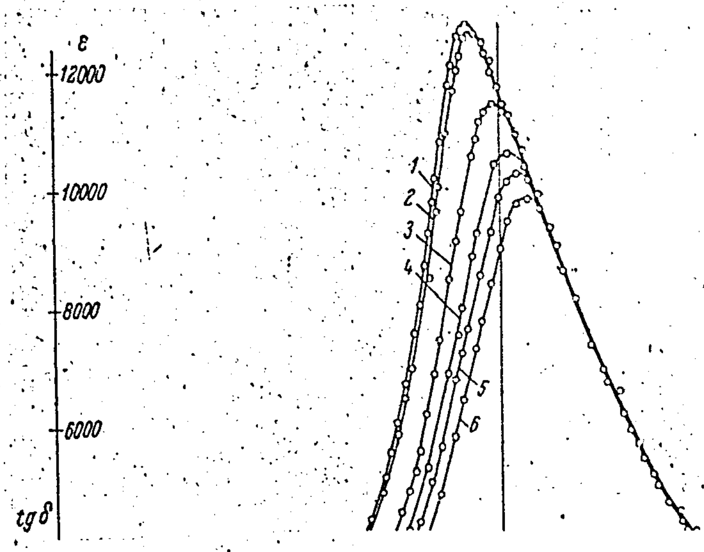

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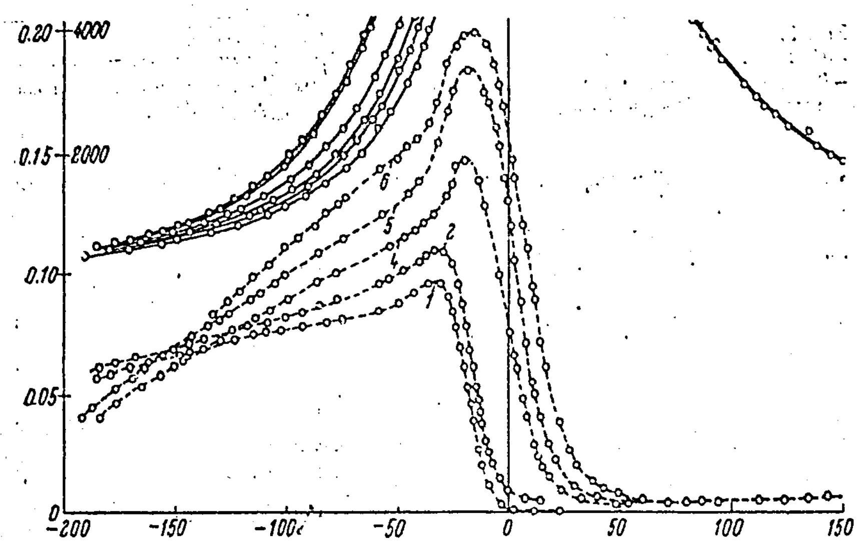

Fig. 2

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86452

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B006/B060

9,2181 (also 1162)

AUTHORS: Smolenskiy, G. A., Isupov, V. A., Agranovskaya, A. I., and Kraynik, N. N.

TITLE: New Ferroelectrics of a Complicated Composition. IV

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 11, pp. 2982-2985

TEXT: This is a report on the discovery of new perovskite-type ferroelectrics, which may be described by the empirical formulas $[Bi_{0.5}Na_{0.5}]TiO_3$ and $[Bi_{0.5}K_{0.5}]TiO_3$. The Curie temperatures of these compounds are 320° and 380°C, respectively. The compounds were prepared by mixing the initial substances Bi_2O_3, TiO_2, K_2CO_3, and Na_2CO_3 in a stoichiometric ratio, and by sintering them in the air at 1120-1140 (Bi-Na) and 1060°C (Bi-K) for an half an hour to two hours. The perovskite structure of the compounds thus obtained was established by X-rays. The parameters of the elementary cells of the two compounds were found to be a = 3.88 and 3.94 A, respectively. In the said compounds, the authors determined ε, $\tan\delta$,

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New Ferroelectrics of a Complicated Composition. IV

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B006/B060

the relative longitudinal expansion $\Delta l/l$ and the coefficient of linear expansion α as temperature functions. Results are shown in Figs. 1 and 2. A study of polarization revealed that sodium bismuth titanate has a well-shaped almost rectangular hysteresis loop, whereas that of potassium bismuth titanate is far from saturation. The first mentioned compound has at 116°C a spontaneous polarization of 8.0 μcoul/cm^2 and a coercive force of 14 kv/cm. It was further established that also $[Na_{0.5}Bi_{0.5}]ZrO_3$ and $[K_{0.5}Bi_{0.5}]ZrO_3$ have a perovskite-type crystallization. There are 2 figures and 18 references: 15 Soviet, 1 US, and 2 British.

ASSOCIATION: Institut poluprovodnikov AN SSSR, Leningrad (Institute of Semiconductors of the AS USSR, Leningrad)

SUBMITTED: June 30, 1960

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B006/B060

Legend to Figs. 1 and 2: 1) ε at 500 kc, 2) Δl/l, 3) α, 4) tanδ at 1 kc.

Fig. 1

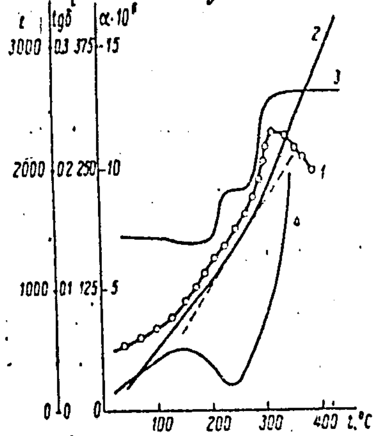
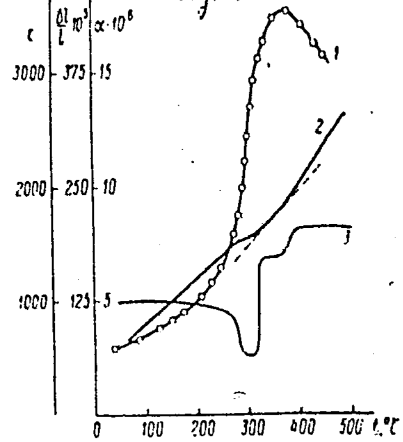


Fig. 2



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85015

9,2180

S/048/60/024/010/024/033
B013/B063

AUTHORS: Isupov, V. A., Agranovskaya, A. I., and Khuchua, N. P.

TITLE: Some Physical Properties of Piezoelectric Lead Ferroniobate and Lead Ferrotantalate

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1960, Vol. 24, No. 10, pp. 1271-1274

TEXT: The authors studied some physical properties of Pb_2FeNbO_6 (Ref. 3) and Pb_2FeTaO_6 (Ref. 4). The samples were produced by the ceramic process. Fig. 1 gives the temperature dependence of ε and $\tan\delta$ at a frequency of 1 kilocycle. It may be seen that lead ferroniobate in weak fields shows a maximum at 110°C and lead ferrotantalate at -25°C. These maxima correspond to the dielectric phase transitions. Below the Curie point, the dielectric polarization of the two compounds is a non-linear function of the electric field strength (cf. Fig. 2). At temperatures near the temperature of the ε-maxima, the curves $\Delta l/l = f(T)$ exhibit distinctly marked peaks which are related to the piezoelectric phase transitions (cf. Fig. 3). At equal

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Some Physical Properties of Piezoelectric Lead Ferroniobate and Lead Ferrotantalate

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B013/B063

temperatures, the coefficients of linear expansion attain minima. The authors' studies proved the existence of Pb_2FeNbO_6 and Pb_2FeTaO_6 with a structure of the perovskite type and piezoelectric properties. The spontaneous polarization of polycrystalline samples of these compounds is obviously less than that of barium titanate. Lead ferroniobate and lead ferrotantalate have also a positive volume electrostriction. Unlike barium titanate, they exhibit no low-temperature phase transitions, at least not down to -190°C. The piezoelectric modulus d_{31} of polycrystalline samples of lead ferroniobate is very similar to that of $BaTiO_3$. Their electrical conductivity is much higher than that of $BaTiO_3$. Samples of lead ferroniobate exhibit a high susceptibility. The authors thank G. A. Smolenskiy for his interest in the work. The present paper was read at the Third Conference on Piezoelectricity, which took place in Moscow from January 25 to 30, 1960. There are 3 figures and 5 Soviet references.

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24.7800 (1142,1144,1162)

85016

S/048/60/024/010/025/033
B013/B063

AUTHOR: Agranovskaya, A. I.

TITLE: Physico-chemical Study of the Formation of Piezoelectric Substances Having a Perovskite-type Structure and a Complex Composition

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1960, Vol. 24, No. 10, pp. 1275 - 1281

TEXT: The author describes the synthesis of a series of compounds with a complex composition, and explains the formation mechanism of these compounds by the example of $PbNi_{1/3}Nb_{2/3}O_3$, $PbFe_{1/2}Nb_{1/2}O_3$, $PbFe_{2/3}W_{1/3}O_3$, and Pb_2MgWO_6. The three first-mentioned compounds are piezoelectric (Refs. 2-5), whereas the fourth is antipiezoelectric (Ref.5). The synthesis was performed by means of a reaction in the solid phase. Table 1 contains general chemical formulas and a list of the compounds synthesized, the conditions of heat treatment, the

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85016

Physico-chemical Study of the Formation of Piezoelectric Substances Having a Perovskite-type Structure and a Complex Composition

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dielectric characteristics of the sinters obtained, and the results of an X-ray structural analysis. Compounds with the following chemical formulas were synthesized: $\left[(A_1^{1+})_{1/2}(A_2^{3+})_{1/2}\right]B^{4+}O_3$, $A^{2+}\left[(B_1^{2+})_{1/3}(B_2^{5+})_{2/3}\right]O_3$, $A_1^{2+}\left[(B_1^{3+})_{1/2}(B_2^{5+})_{1/2}\right]O_3$, $A_1^{2+}\left[(B_1^{2+})_{1/2}(B_2^{6+})_{1/2}\right]O_3$, $A_1^{3+}\left[(B_1^{2+})_{1/2}(B_2^{4+})_{1/2}\right]O_3$. The X-ray structural analysis has shown that compounds with a perovskite-type structure can be synthesized by all combinations of the general chemical formulas. A study of the lattice parameters indicated that, apart from Ba_2MgWO_6 and Pb_2MgWO_6, the ions are not orientated in sublattices, i.e., there are no superlattice lines on the Debye patterns. For several compounds the author determined the specific gravity on polycrystalline samples and on the monocrystals bred by I. Ye. Myl'nikova (Table 2). The results of the chemical analysis of a polycrystalline sample and of the monocrystal

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Physico-chemical Study of the Formation of Piezoelectric Substances Having a Perovskite-type Structure and a Complex Composition

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of $PbNi_{1/3}Nb_{2/3}O_3$ agree with the formula suggested for this compound (Table 3). The monocrystal was analyzed by N. N. Parfenova. The formation mechanism of the above-mentioned compounds was studied by way of X-ray phase-shift analysis and chemical phase-shift analysis. Furthermore, some burned products of several binary compounds were examined by X-ray phase-shift analysis (Table 4). In the case of $PbNi_{1/3}Nb_{2/3}O_3$, $PbFe_{1/2}Nb_{1/2}O_3$, and $PbFe_{2/3}W_{1/3}O_3$ it was found that first a phase with a structure of the pyrochlorine type is formed, followed by a phase with perovskite-type structure. For numerous compounds it was not possible to bring the reaction in the solid phase to an end and to obtain the corresponding perovskites. In the case of Pb_2MgWO_6, there appears first a phase with a scheelite-type structure. The synthesis of the niobates $3PbO.Nb_2O_5$ and $2PbO.Nb_2O_5$ is accompanied by the formation of intermediate products. The content of bound PbO in sinters of $PbNi_{1/3}Nb_{1/2}O_3$ is

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Physico-chemical Study of the Formation of Piezoelectric Substances Having a Perovskite-type Structure and a Complex Composition

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B013/B063

given in a Fig. for each temperature of heat treatment. The author thanks G. A. Smolenskiy for his interest in the work. The present paper was read at the Third Conference on Piezoelectricity, which took place in Moscow from January 25 to 30, 1960. There are 1 figure, 4 tables, and 12 references: 7 Soviet.

ASSOCIATION: Institut poluprovodnikov Akademii nauk SSSR (Institute of Semiconductors of the Academy of Sciences USSR)

Card 4/4

20796

S/181/61/003/003/022/030
B102/B205

9,4300 (1136,1145,1147,1153)

AUTHORS: Smolenskiy, G. A., Isupov, V. A., and Agranovskaya, A. I.

TITLE: Laminated ferroelectrics of the oxygen-octahedron type

PERIODICAL: Fizika tverdogo tela, v. 3, no. 3, 1961, 895-901

TEXT: In an earlier paper (Ref. 1: FTT, I, 1, 169, 1959), the authors have uttered the opinion that compounds of the general formula $ABi_2B_2O_9$ ($A = Ca^{2+}$, Sr^{2+}, Ba^{2+}, Pb^{2+}, Bi^{3+}; $B = Ti^{4+}$, Nb^{5+}, Ta^{5+}) have ferroelectric properties. Now they report on the proof of these properties and the manufacture of the new group of ferroelectrics. In the lattice of these compounds, perovskite-type layers $(AB_2O_7)^{2-}$ consisting of BO_6 octahedra alternate with $\left[(Bi_2O_2)^{2+}\right]_x$ layers. Such crystals have face-centered, orthorhombic unit cells which, in first approximation, are considered to be body-centered tetragonal cells. The specimens (8-10 mm diameter, 0.5-2 mm thickness) were made of powdered oxides or salts of the corresponding metals: PbO, $SrCO_3$, $BaCO_3$, Bi_2O_3 trade-marked "ЧДА" (pro analysi), $CaCO_3$, TiO_2

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trade-marked "Ч" (pure), Nb_2O_5 (containing Nb 99.4%, Ta 0.2%, Fe 0.06%, Si 0.04%), and Ta_2O_5 (TiO_2 < 0.25%, Fe_2O_3 0.18%). The specimens were pressed from the powder mixtures, heated to 700°C (for 4 hr) in air, again powdered and heated to temperatures which are listed in Table 1 (holding time: 1 hr). The losses in weight (in lead and bismuth oxides) are given in %. The X-ray structural analysis was carried out by I. G. Ismailzade. The temperature dependence of the initial values of ε for some of the compounds is shown in Figs. 2 and 3; the course of ε(T) on heating and cooling is shown for $PbBi_2Nb_2O_9$. tan δ of these compounds at 1 kc and room temperature was equal to 0.01. It is seen that some compounds show a monotonic increase of ε without an extremum, while other compounds have broad or sharp maxima. The highest value of ε is reached by $BaBi_4Ti_4O_{15}$. Fig. 4 shows the temperature dependence of ε and tan δ of the solid solutions $(Pb_{1-x}Ba_x)Bi_2Nb_2O_9$ at 1 kc, and of the compound $BaBi_2Nb_2O_9$ at 1 kc (continuous line) and 450 kc (broken line). The figures beside the curves are the values of x. Fig. 5 shows the x-dependence of the temperature at which

20796

Laminated ferroelectrics ... S/181/61/003/003/022/030 B102/B205

ε reaches its maximum for $(Pb_{1-x}Ba_x)Bi_2Nb_2O_9$ at 1kc (1) and 450 kc (2), and for $(Pb_{1-x}Sr_x)Bi_2Nb_2O_9$ at 500 kc (3). The chemical composition (1) and the temperatures of the phase transition (2) of niobates (a), tantalates (b), and titanates (c) studied are listed in Tables 2 and 3. It may be seen that all compounds of the new group of ferroelectrics have a comparatively high phase-transition temperature. This fact is attributed to the presence of Bi^{3+} ions. Concerning the selection of the ions A and B, it is necessary to follow the instruction given in Ref. 8 (G. A. Smolenskiy and A. I. Agranovskaya, FTT, I, 10, 1562, 1959) for the manufacture of such ferroelectrics. The fact that the radii of the ions A^{2+} and Bi^{3+} vary considerably is held responsible for the disturbance of the arrangement of the cations forming the compound $CaBi_2Nb_2O_9$ in several compounds with a laminated structure. This explains the width of the phase transition (blurredness) and the occurrence of relaxation polarization in $BaBi_2Nb_2O_9$. There are 5 figures, 3 tables, and 8 references: 7 Soviet-bloc and 1 non-Soviet-bloc.

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S/181/61/003/003/028/030
B102/B205

9,4300 (1136, 1145, 1155)

AUTHORS: Smolenskiy, G. A., Kraynik, N. N., and Agranovskaya, A. I.

TITLE: Antiferroelectric properties of some solid solutions on the basis of $PbMg_{1/2}W_{1/2}O_3$

PERIODICAL: Fizika tverdogo tela, v. 3, no. 3, 1961, 981-990

TEXT: Antiferroelectrics of the perovskite type have so individual properties that no "typical" compound (such as $BaTiO_3$ in the group of ferroelectrics) can be found. When investigating antiferroelectric effects, it is therefore necessary to compare the properties of solid solutions with various antiferroelectrics as basic material. One of the most important problems in the field of antiferroelectrics is the stability of the ferroelectric and the antiferroelectric phases. A study has now been made of this problem with the aid of the new antiferroelectric $PbMg_{1/2}W_{1/2}O_3$, and the effect of a substitution of the ions A or B in this compound has been studied (A denotes the ions contained in perovskite-type lattices ABO_3, in sites with the coordination number 12, and B denotes the

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ions in sites with the coordination number 6). The solid solutions $PbMg_{1/2}W_{1/2}O_3$ were synthesized with $PbTiO_3$, $PbMg_{1/3}Nb_{2/3}O_3$, $BaMg_{1/2}W_{1/2}O_3$, and $CaMg_{1/2}W_{1/2}O_3$ through a reaction in the solid phase. The first heat treatment was performed at 700°C with a holding time of 4 hr at the maximum temperature, and the last heat treatment was carried out in PbO vapor at 1000-1050°C (1 hr at the maximum temperature). The losses in weight of volatile oxides amounted to 2% approximately. The structure of the resulting solid solutions was checked radiographically by M. F. Bryzhina. Next, the relative longitudinal extension $\Delta l/l$, ε, and tan δ were measured as temperature functions in weak fields; furthermore, ε, tan δ, and polarization P as functions of the electric field strength E. These functions are shown in diagrams. Summing up: 1) The ferroelectric phase appears in the solid solutions of $PbMg_{1/2}W_{1/2}O_3$ with $PbTiO_3$ and $PbMg_{1/3}Nb_{2/3}O_3$, a sequence of phases being observed in a certain concentration range at elevated temperature. The ferroelectric phase is followed by the antiferroelectric phase, and the latter again by the paraelectric phase. This sequence deviates from that observed in solid solutions on the basis of $PbZrO_3$ and $NaNbO_3$. 2) Solid solutions with $BaMg_{1/2}W_{1/2}O_3$ and $CaMg_{1/2}W_{1/2}O_3$ showed no ferroelectric phase. A new, obviously antiferroelectric phase appears in solid solutions with $CaMg_{1/2}W_{1/2}O_3$. 3) In the antiferroelectric phase of solid solutions with $PbTiO_3$ and $PbMg_{1/3}Nb_{2/3}O_3$ at a concentration of the second component of 5-7 and 20-25%, respectively, a forced phase transition into the ferroelectric phase, occurs in a strong electric field. The critical field within which this phase transition occurs, increases with a rise in temperature. 4) In solid solutions on the basis of $PbMg_{1/2}W_{1/2}O_3$, the phase transition from the antiferroelectric into the paraelectric phase is accompanied by a reduction in volume. Thus, the occurrence of the antiferroelectric state may give rise to a reduction in volume of the primary unit cell (solid solution on the basis of $PbZrO_3$) or an increase in volume (solid solution on the basis of $PbMg_{1/2}W_{1/2}O_3$) as compared to the paraelectric state. 5) Certain compositions of solutions with $PbTiO_3$ and $PbMg_{1/3}Nb_{2/3}O_3$ show both ferroelectric and relaxative properties. 6) Experimental data on the relative stability of the ferro-

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electric and antiferroelectric phases in the solid solutions studied can be qualitatively explained if electrostatic dipole-dipole interaction is assumed. It should be taken into account that the electron polarizability of the oxygen ion decreases as the packing density of the ions, in the oxygen octahedron increases. There are 9 figures and 18 references: 12 Soviet-bloc and 6 non-Soviet-bloc. The reference to the English-language publication reads as follows: W. J. Merz, Phys. Rev. 91, 513, 1953.

ASSOCIATION: Institut poluprovodnikov AN SSSR Leningrad (Institute of Semiconductors, AS USSR, Leningrad)

SUBMITTED: September 12, 1960

Figures 2 and 3: Phase distribution as a result of dielectric measurements at 1000 cps.
Legend: 1) paraelectric phase, 2) ferroelectric phase, 3) antiferroelectric phase.
Legend to Fig. 4: $\varepsilon(t)$ for the alloy with a Ti containing second component; the figures express the content of the second component in mole%.

24.7800 (1043, 1145, 1035)
24.2200 1144, 1147, 1158,

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S/048/61/025/011/004/031
B108/B138

AUTHORS: Smolenskiy, G. A., Isupov, V. A., Kraynik, N. N., and Agranovskaya, A. I.

TITLE: Coexistence of the ferroelectric and ferrimagnetic states

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 25, no. 11, 1961, 1333-1339

TEXT: This paper was read at the Conference on ferromagnetism and antiferromagnetism in Leningrad, May 5-11, 1961. The authors studied substances having both ferroelectric and ferromagnetic or antiferromagnetic properties. Among the crystals known so far only the perovskite-type structures include a greater number of ferroelectrics and substances with magnetic ordering. If a perovskite-type crystal ABO_3 contains a definite concentration of ions of transition elements with non-compensated spins, magnetic ordering may arise. Ferromagnetic properties will arise when the A and B ions have high polarizability. In perovskite-type crystals, ferrimagnetism may be achieved by a certain ordering of the ions in the B sublattice in solid solutions. The latter are assumed to have the structure

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B108/B138

Coexistence of the ferroelectric and...

$(1-x)A'B'O_3 - xA''B_{0.5}''B_{0.5}'''O_3$ where the first compound is antiferromagnetic and the second paramagnetic. x denotes the concentration of the second component (mole per cent). The saturation magnetic moment of one ABO_3 unit is calculated under the assumption that the exchange interaction within the B sublattices may be neglected. It was found as

$$m_s = 0.5(m_I - m_{II}) = 0.5\left\{\left[m'(1-x) + m''x\right]\left[1 - E(k_{II})\right] - m'(1-x)\left[1 - E(k_I)\right]\right\}$$

m_I and m_{II} are the magnetic moments of sublattices I, II, respectively, m' and m" the moments of the ions B' and B", k_I and k_{II} the contributions of nonmagnetic ions to the overall ion number in the sublattices I and II, $E(k) = 6k^5 - 5k^6$ is the probability that a magnetic ion in one of the sublattices has not more than one nearest neighbor among the magnetic ions in the other sublattice. In the considered case, $k_I = 0$ and $k_{II} = x$. In particular the authors studied the solid solution $(1-x)Pb(Fe_{2/3}W_{1/3})O_3 - xPb(Mg_{1/2}W_{1/2})O_3$ which was obtained by sintering the oxides at 900-920°C. X-ray phase analyses were carried out by

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M. F. Bryzhina. At x concentrations of between 0 and 0.88, the solid solution was ferroelectric. A dielectric hysteresis loop was observed at the temperature of ferroelectric phase transformation. At concentrations above 0.88, the solid solution proved to be antiferroelectric. Fig. 3 shows the magnetic moment of the solid solution at x = 0.3 plotted against magnetic field strength. The spontaneous moment m_s was determined from these curves by means of the relation $m = m_s + \chi H$. A "range" rather than a "point" of phase conversion was observed. The exchange interaction energy, and consequently also the Curie temperature, are proportional to the number of interacting Fe-O-Fe pairs per "active" iron ion. In perovskite, this number of interactions is $n(k_I,k_{II}) = (1-k_I)\left[1-E(k_{II})\right](1-k_{II})\left[1-E(k_I)\right]$. The number of magnetic ions participating in ferrimagnetism is $N = 0.5\left\{(1-k_I)\left[1-E(k_{II})\right] + (1-k_{II})\left[1-E(k_I)\right]\right\}$. The Curie temperature can be calculated from these relations: $\Theta_M(k_I,k_{II}) = \frac{n(k_I,k_{II})}{N}\cdot\Theta_M(0,0)$, where $\Theta_M(0,0)$ is the

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Neel temperature of the substance containing no nonmagnetic ions. Experimental and theoretical results agree well. The calculated magnetic moment is too high, which indicates that the magnetic ordering of the ions is not complete. There are 4 figures, 1 table, and 9 references: 4 Soviet and 5 non-Soviet. The three most recent references to English-language publications read as follows: Orgel L. E., J. Chem. Soc., no. 12, 3815 (1959); Gilleo M. A., J. Phys. Chem. Solids, 13, 33 (1960); Fang P. H. et al., Bull. Amer. Phys. Soc., ser. II, 5, no. 1, part 1, 57 (1960).

ASSOCIATION: Institut poluprovodnikov Akademii nauk SSSR (Institute for Semiconductors of the Academy of Sciences USSR)

AGRANOVSKAYA, A. I.

Dissertation defended for the degree of Candidate of Technical Sciences at the Institute of Silicate Chemistry imeni I. V. Grenbenshchikov in 1962:

"Synthesis and Investigation of Compounds with the Perovskite Type Structure in Polycomponent Oxide System."

Vest. Akad. Nauk SSSR. No. 4, Moscow, 1963, pages 119-145

24,7100

45678

S/070/63/008/001/018/024
E132/E460

AUTHORS: Isupov, V.A., Agranovskaya, A.I., Bryzhina, M.F.

TITLE: Crystallochemical characteristics and certain physical properties of compounds with the structure of the hexagonal tungsten oxygen bronzes

PERIODICAL: Kristallografiya, v.8, no.1, 1963, 108-110

TEXT: In the perovskite structure there are canals of square cross-section, in the tetragonal potassium tungsten bronzes canals of tetragonal and pentagonal cross-section and in the hexagonal rubidium tungsten bronzes large canals of hexagonal cross-section. In each case the carcase is made up of linked WO_6 octahedra. In the latter structure the alkali ions (A) are 12-coordinated by oxygen at a distance p, 6-coordinated by oxygen at a distance q, and 2-coordinated by other A ions. This gives a total coordination of 20. These three conditions demand that the A ions should have radii $1.732\ R_o$, $1.449\ R_o$ and $1.414\ R_o$ so these conditions cannot be satisfied simultaneously except by a reformable ion. To enter into this structure an A ion must be sufficiently big, must be sufficiently deformable and must not be highly charged. The following compounds have been found:

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KRAYNIK, N.N.; ISUPOV, V.A.; BRYZHINA, M.F.; AGRANOVSKAYA, A.I.

Crystal chemistry of ferroelectrics having a structure of the type of tetragonal oxygenic tungsten bronze. Kristallografiia 9 no.3:352-357 My-Je '64. (MIRA 17:6)

1. Institut poluprovodnikov AN SSSR.

APPROVED FOR RELEASE: 06/05/2000 CIA-RDP86-00513R000100520017-5"

ISUPOV, V.A.; AGRANOVSKAYA, A.I.; BRYZHINA, M.F.

Crystallochemical characteristics and certain physical properties of compounds with the structure of hexagonal tungsten oxygenic bronze. Kristallografiia 8 no.1:108-110 Ja-F'63 (MIRA 17:7)

1. Institut poluprovodnikov AN SSSR.

L 2301-66

ACCESSION NR: AP5022272 UR/0363/65/001/007/1177/1183
549.73:539.24

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AUTHOR: Vinnik, M. A.; Agranovskaya, A. I.; Semenova, N. N.

TITLE: X-ray diffraction and microstructural study of phase relationships in the formation of barium cobalt hexaferrite Ba sub 3 Co sub 2 Fe sub 24 O sub 41 (Co sub 2 Z)*

SOURCE: AN SSSR. Izvestiya. Neorganicheskiye materialy, v. 1, no. 7, 1965, 1177-1183.

TOPIC TAGS: barium compound, cobalt compound, iron compound

ABSTRACT: The object of the work was to study the phase relationships during the formation of Co_2Z* and to establish the temperature region of its existence. The compound was synthesized from ferric oxide, cobalt oxide, and barium carbonate by pressing and sintering powder mixtures, and the phase composition of the products was determined by X-ray diffraction and microstructural examination. It is found that Co_2Z* does not form directly from the original oxides, but by means of the intermediate compounds $BaFe_{12}O_{19}$ (M)* and $Ba_2Co_2Fe_{12}O_{22}$ (Co_2Y)*. The compound Co_2Z* starts to form at 1150C, and is stable when heated in air up to

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1350C. Above 1350C, it decomposes into $BaCo_2Fe_{16}O_{27}$ (Co_2W)*, $BaFe_2O_4$ (B)*, $BaFe_{12}O_{19}$ (M)*, and the solid solution $Co_\delta Fe_{1-\delta}{}_2O_4$ (S')*; this decomposition is due to the reduction of Fe^{3+} to Fe^{2+} at high temperatures. The compounds Co_2Y* and Co_2W* also decompose above 1250 and 1300C, respectively. "The authors are deeply grateful to A. A. Shvarts for constant interest in this work." Orig. art. has: 6 figures and 1 table.

ASSOCIATION: None

SUBMITTED: 22Mar65 ENCL: 00 SUB CODE: IC, GC

NO REF SOV: 001 OTHER: 005

*Abitrary Symbols used by authors to disignate various phases in their paper. $M=BaFe_{12}O_{19}$, $B=BaFe_2O_4$, $S=CoFe_2O_4$, $S'=Co_\delta Fe_{1-\delta}^{2+}Fe_2^{3+}O_4$, $Co_2Y=Ba_2Co_2Fe_{12}O_{22}$, $Co_2Z=Ba_2Co_2Fe_{24}O_{41}$, $Co_2W=BaCo_2Fe_{16}O_{27}$

KC

Card 2/2

SHVARTS, A.A.; DUKHOVSKAYA, Ye.L.; AGRANOVSKAYA, A.I.

New transparent garnet. Izv. AN SSSR. Neorg. mat. 1 no.9: 1617-1619 S '65. (MIRA 18:11)

L 11509-66 EWT(m)/EPF(n)-2/EWP(t)/EWP(b) IJP(c) JD/JG

ACC NR: AP5025803 SOURCE CODE: UR/0363/65/001/009/1617/1619

AUTHOR: Shvarts, A. A.; Dukhovskaya, Ye. L.; Agranovskaya, A. I.

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ORG: none

TITLE: New transparent garnet

SOURCE: AN SSSR. Izvestiya. Neorganicheskiye materialy, v. 1, no. 9, 1965, 1617-1619

TOPIC TAGS: garnet, gallium compound, calcium compound, niobium compound, CRYSTAL OPTIC PROPERTY, X RAY DIFFRACTION ANALYSIS

ABSTRACT: In order to produce optically transparent compounds, an attempt was made to synthesize the compound $Ca_3Ga_{3.5}Nb_{1.5}O_{12}$ and solid solutions $Ca_3Fe_xGa_{3.5-x}Nb_{1.5}O_{12}$ (where $0 \le x \le 0.5$). The samples were prepared by mixing $CaCO_3$, Ga_2O_3, Nb_2O_5, and Fe_2O_3 in an agate mortar and firing at high temperatures. The products were analyzed by x-ray diffraction with a URS-50I unit. Analysis showed that in the absence of Fe_2O_3 or when it is introduced in amounts corresponding to values of x from 0.1 to 0.3, single-phase solid solutions with a garnet structure are formed (beginning at 1250°C for x = 0 and 1150°C for x = 0.1 and 0.3). It was found that

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ACC NR: AP5025803

in the compound $Ga_3Ga_{3.5}Nb_{1.5}O_{12}$, the niobium ions occupy only octahedral positions. A 100-μ thick polycrystalline plate of this compound is transparent in the 0.8-10μ range. Orig. art. has: 1 figure, 1 table.

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SUB CODE: 08, 07 SUBM DATE: 03May65/ ORIG REF: 001/ OTH REF: 005

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