tigations show that this method can provide information simultaneously about a number of deep dislocation energy levels in silicon single crystals. The results obtained by thermostimulated depolarization are compared with data obtained by traditional methods (Hall effect, spectral dependence of photoconductivity).

It is shown that a slip plane assumes the role of a new two-dimensional defect of the revealed structure. This two-dimensional defect is made up of an assembly of point-defect complexes which are formed in dislocation conditions and are left in the slip plane. This is caused by a smaller diffusion coefficient compared to that of the point defects. It is observed that part of point defects gathered by dislocation are transported by pipe diffusion to the crystal surface where they are fixed as microprecipitates. The dependence of the observed effects on temperature and duration of deformation, on thermal treatment conditions, and on impurity contents of the crystals has been investigated.

of bringing the dislocation to the starting position,it turned out possible to reveal a number of essential characteristics of dislocation-point defects interaction.It has been shown that the dislocation mobility is determined not only by the initial impurity contents of the crystals,but by point defects collected by the dislocation during its motion.The concentration and structural state of such defects depend on the dislocation velocity,pathway length and thermal treatment conditions upon bringing the dislocation to the starting position.It has been found that impurities collected by the dislocation as well as complexes,forming from gathered impurities in the field of dislocation microstresses, determine the kink mobility and give rise to a decrease of dislocation velocity and to the appearence of the starting stress.The high temperature data obtained for Ge can be explained under the assumption of the structural state changes of collected impurities occuring in some temperature range.It has been found that the dislocation velocity increases during the movement of the same dislocation as its motion direction is reversed.It is shown that this effect is not connected with the different resistance to the motion of partial dislocations,from which the perfect dislocation consists,but it is probably stipulated by the influence of the change in point defects state in the glide plane swept off by dislocation.The results obtained necessitate an account of the various manifestations of dislocation-point defects interaction in a real crystal leading to the essential change of the potential relief of the crystal lattice in the volume adjacent to the dislocation and in the region swept off by moving dislocation.

11.3-07   DISLOCATION MOBILITY IN SEMICONDUCTOR CRYSTALS IN CONNECTION WITH THEIR REAL STRUCTURE. By I.E. Bondarenko, V.I. Nikitenko, B.Ya. Farber, Institute of Solid State Physics Academy of Sciences of the USSR. Chernogolovka, Moscow distr., USSR.

The investigations of the dislocation mobility in covalent crystals have revealed essential contradictions between the experimental data and predictions of the theory of the dislocation mobility in a deep Peierls potential of the ideal lattice.To study the cause of the revealed discrepancies an investigation of dislocation mobility in Ge and Si has been made under conditions permitting one to select the contribution of the dislocation splitting and dislocation-point defects interaction to the movement of dislocations.The measurements of the dislocation velocity in Ge have been fulfilled within a high temperature range $T > 600°C$,that have not been studied earlier.It has been found that at low stresses the activation energy for the dislocation motion decreases essentially as compared with the low temperature range.The analysis has shown that the behaviour of the temperature dependence of the velocity cannot be described in terms of the theoretical models based on the assumption of the influence of point defects on kink migration,even if the dislocation splitting and the reduction of point defects concentration with rising temperature are taken into account.It was,however,observed,that the results can qualitatively be described by these models at low temperature $T < 600°C$.Investigating the dislocation mobility dependence in Si and Ge on the conditions

11.4-01   THE DETERMINATION OF DEBYE CHARACTERISTIC TEMPERATURES OF CRYSTALS FROM X-RAY POWDER DIFFRACTION INTENSITIES. By S. S. Lu and J. K. Liang,Institute of Physics, Academia Sinica, Beijing, China.

The methods of determining Debye characteristic temperatures from X-ray powder diffraction intensities have been fully discussed.

In the case of homogeneous and isotropic crystals,if the natural logarithms of the ratios of calculated intensities to observed intensities $\ln(I_{calc.}/I_{obs.})$ of all diffraction lines are plotted against $\sin^2\theta/\lambda^2$, the slope of the straight line obtained should give $2B$, where B is the Debye parameter.

For anisotropic crystals,if $\ln(I_{calc.}/I_{obs.})$ of (hk0) and (001) reflexions are plotted against $\sin^2\theta/\lambda^2$ respectively, the two straight lines obtained should intercept at the same point on the ordinate axis. The slopes of the straight lines should give $2B_{||}$ and $2B_{\perp}$,where $B_{||}$ and $B_{\perp}$ represent the Debye parameters parallel and perpendicular to the principal axis respectively.

For inhomogenous crystals, if there are two kinds of atoms(a) and (b) in the crystal, then the diffraction lines in the Debye-Scherrer photograph may be classified into two categories: the structure factors are either the sum F^s or the differece F^d of the structure factors of the respective atoms. Owing to the fact that both F^s and F^d are functions of $\sin\theta/\lambda$, so,if the observed values of $F^s_{obs.}$ and $F^d_{obs.}$ are plotted against $\sin\theta/\lambda$, two smooth curves should be obtained. From these two curves the corresponding values

of $F_{obs.}^{d}$ or $F_{obs.}^{5}$ could be found at the same abscissas
as $F_{obs.}^{5}$ or $F_{obs.}^{d}$. . If the corresponding pairs of valu-
es are multiplied by proper coefficients and
then be added or subtracted, a series of values
of $F_{obs.}^{+}$ and $F_{obs.}^{-}$ could be obtained which are now pure
functions of F_{a} and F_{b} . Then if $\ln(F_{a}/F_{obs.}^{+})$
and $\ln(F_{b}/F_{obs.}^{-})$ are plotted against $\sin^{2}\theta/\lambda$ respec-
tively, two straight lines could be obtained
which should intercept at the same point on the
ordinate axis, the slopes of which represent
respectively B_{a} and B_{b} .

In the Debye theory of specific heats, the Debye
parameter B may be expressed as $(6\hbar^{2}T/Mk\Theta^{2})\{\phi(x)+x/4\}$,
where h and k represent Plank constant and Bol-
tzmann constant respectively, M is the mass of
the atom, and T is the absolute temperature at
the time of taking Debye-Scherrer photographs. Θ_{D}
is the Debye characteristic temperature, $x=\Theta_{D}/T$,
and $\phi(x)$ is a function of x, given in original
Debye theory. If we let $G=BMk T/6\hbar^{2}$, then $\phi(x)+x/4=Gx^{2}$.
Solution of this equation may be performed gra-
phically. Thus by making $y_{1}=Gx^{2}$ and $y_{2}=\phi(x)+x/4$, the
plotting of these two equations should give two
curves, the intersection of which should give
the value of x determining the characteristic
temperature at that temperature.

By means of these methods, the characteristic
temperature of Al, Au and Pb have been determined
to be 376K, 205K and 90K respectively. In the
case of Zn, the characteristic temperature paral-
lel to the principal axis is 212K, which that per-
pendicular to it is 328K the difference being
116K. For CaF_{2} crystals, the characteristic tem-
perature of Ca^{2+} ion is 400K, while that of F^{-} ion
is 476K, the difference being 76K.

11.4-02   DEBYE-WALLER FACTORS OF ZINC BLENDE
STRUCTURE COMPOUNDS. By John S. Reid, Department of
Natural Philosophy, University of Aberdeen, Aberdeen,
Scotland.

Tables are presented of the Debye-Waller factors for
a substantial number of zinc blende structure materials
over the temperature range 1K to 1000K (where
appropriate). The factors are calculated using
eigendata from up to 3×10^{6} phonon modes obtained
from the established lattice dynamical models including
the shell model, the valence shell model and the
deformation dipole model. Taking good account of the
zerophonon contribution the sampling error is reduced
to negligible proportions. These figures provide the
best harmonic Debye-Waller factors against which
experimental results may be assessed for consistency,
quasi-harmonic and other anharmonic contributions, and
possible dynamic deformation effects. For most of the
materials a comparison is made of the Debye-Waller
factors from more than one lattice dynamical model in
order to assess whether the Debye-Waller factor is a
useful observable to distinguish between lattice
dynamical models which fit the symmetry direction
frequencies comparably well. Further, values are given
for the Debye-Waller factors of the shells in the
shell models in order to highlight that some of the
electron distribution is modelled to vibrate with
substantially different mean square displacements
compared with the core. Since this feature of the
shell models cannot be uniquely determined from phonon
frequency measurements, a discussion is given of the
possible role of Debye-Waller factors determined by
X-rays in providing lattice dynamical information of
real value.

11.4-03   LOWEST ORDER ANHARMONIC THERMAL SCATTERING
OF X-RAYS BY SILICON-LIKE CRYSTALS. By J.D.Pirie,
Department of Natural Philosophy, University of
Aberdeen, Aberdeen AB9 2UE, Scotland.

The lowest order anharmonic contribution to
thermally scattered X-rays has been calculated for
diamond, silicon, germanium and α-tin. This term
can be regarded as an interference between the
harmonic one phonon and two phonon scattering
processes. The calculations were based on an
anharmonic interaction restricted to nearest
neighbours and used lattice eigenfrequency-eigenvector
data obtained from published parameters for lattice
dynamics models. Most of these models had been fitted
to measured phonon frequencies.

Results will be presented for the main symmetry
directions and other representative points in
reciprocal space. This anharmonic contribution to
the thermal scattering may be positive or negative
and its magnitude will be compared with the harmonic
thermal scattering and Compton scattering over a range
of temperatures.

11.4-04   STUDY OF ACOUSTOELECTRIC PHONONS BY ANOM-
ALOUS TRANSMISSION OF X-RAYS. By L. D. Chapman, R.
Colella and R. Bray, Physics Department, Purdue Univers-
ity, W. Lafayette, IN 47907.

Intense beams of non-equilibrium acoustic phonons can be
generated in piezoelectric crystals by application of an
electric field. In our experiments with InSb the elec-
tric field was applied parallel to the [110] direction,
along which acoustoelectric (A.E.) amplification takes
place. Strong beams of [110] FT phonons are generated,
and the resulting attenuation of anomalous transmission
(A.T.) along planes parallel and perpendicular to [110]
was investigated in detail. Since the phonon beams are
localized in travelling domains, a time resolved tech-
nique for recording diffraction patterns was used. Up
to 14 diffraction patterns with 0.5 μsec resolution time
were recorded simultaneously for each rocking curve,
which was sufficient to observe the whole time evolution
of the acoustic flux generated by each phonon domain.
The sensitivity of anomalous transmission to small en-
hancements of atomic vibrations, in conjunction with the
time resolved technique, has enabled us to gain valuable
information on phonon lifetimes, frequency downshifts,
and mode conversions. It has been possible, for example,
to ascertain the existence of weak modes that are not
A.E. amplified, namely: [110] L and [110] ST. These
are due partly to mode conversion at the walls of the
crystal, but also, to an appreciable extent, to a mech-
anism of mode conversion inherently present in the
travelling acoustic domain, the nature of which mech-
anism is at present unknown. This mechanism is such
that the [110] L and [110] ST phonons are continuously
produced as by-products of the intense [110] FT flux,
probably via anharmonic interactions. Since these
phonons are not able to survive and to undergo A.E.
amplification, they appear to propagate with the speed
of the [110] FT phonons.