11.6-05   "FORBIDDEN" REFLECTIONS DUE TO
ANISOTROPIC POLARIZABILITY OF CRYSTALS.
By V.E.Dmitrienko, All-Union Research Insti-
tute of Physical-Technical and Radiotechnical
Measurements, Moscow, U.S.S.R.

The effect of the anisotropy of X-ray pola-
rizability on the conditions limiting possible
reflections is discussed. If crystallographi-
cally equivalent atoms have differently orien-
tated anisotropy of polarizability, they have
different scattering power and the "forbidden"
reflections may be excited (D.H.Templeton and
L.K.Templeton (1980), Acta Cryst., A36, 237).
In the present work some unusual properties
of these reflections are treated in detail.
The symmetry properties both of the tensor
of X-ray susceptibility $\hat{X}(\vec{r})$ and of its Fouri-
er coefficients $\hat{X}_H$ are determined. It is shown
that these symmetry properties may result in
nonvanishing of even those $\hat{X}_H$ which are identi-
cally zero if the known reasons (such as non-
spherical electron distributions and anharmo-
nicity and anisotropy of thermal vibrations
(B.Dawson (1967) Proc. Roy. Soc., A298, 255;
V.A.Belyakov (1971) Fiz. Tverd. Tela, 13,3320))
are taken into account. Such reflections have
been observed in white tin (B.Borie (1978)
Phys. Stat. Sol., 47,K39; D.W.Field,ibid.,K43).
From the symmetry properties of $\hat{X}_H$ it is
also shown that the intensity and polarization
properties of the 001 (1=2n+1) forbidden ref-
lections in TiO_2 (rutile) are smoothly depen-
dent on the angle of rotation about the [001]
axis. Another example is given by screw-axis
forbidden reflections with elliptic or even
circular polarization of reflected beam. These
unusual properties of considered reflections
are useful for their experimental observation.

11.6-06   DIFFRACTION BIREFRINGENCE AND DI-
CHROISM OF X-RAYS IN CRYSTALS. By V.E.Dmitri-
enko and V.A.Belyakov, All-Union Research
Institute of Physical-Technical and Radiotech-
nical Measurements, Moscow, U.S.S.R.

The diffraction corrections to refractive
index, birefringence and dichroism of X-rays
in crystals are theoratically examined in
assumption that X-ray beam is out of Bragg
condition. It is shown that in this case the
diffraction correction from each reflection
is rather small (approximately $\hat{X}_H\hat{X}_{\bar{H}}{\sim}10^{-11}-10^{-12}$;
$\hat{X}_H$ is the Fourier coefficient in the expansion
of susceptibility), but the sum over all ref-
lections has measurable value. For example,
the diffraction correction $\Delta n=2\cdot10^{-9}$ for LiF
and $\Delta n=2\cdot10^{-8}$ for Ni; both values were calcu-
lated for the wavelength $\lambda=1.54$ Å and for
X-ray beam propagating along [001] direction.
Although these corrections are very small,
they should be taken into account in the pre-
cise interferometric determination of atomic
scattering factors. Note that: I) Δn is
strongly dependent on the wavelength and the
propagation direction; 2) Δn is weakly de-
pendent on crystal perfection and its value
may be determined from the dynamical diffrac-
tion theory or from the relevant theory for
mosaic crystals (V.E.Dmitrienko and V.A.Belya-
kov (1980) Acta Cryst., A36, 1044).
If the angular deviation of propagation di-
rection from the Bragg one $\Delta\theta$ for some reflec-
tion H is not too large ($\Delta\theta{\sim}I$ but $|\Delta\theta|{\gg}|\hat{X}_H|$),
the diffraction corrections to the refraction
index are mostly due to this reflection. For
σ and π polarized waves these corrections are

given by the following relations: $\Delta n_\sigma=$
$=\hat{X}_H\hat{X}_{\bar{H}}/(\Delta\theta\sin2\theta_B)$ and $\Delta n_\pi=\Delta n_\sigma\cos^2 2\theta_B$. It should
be emphasized that Δn_σ and Δn_π rather slowly
(as $\Delta\theta^{-1}$) decrease with $\Delta\theta$ increasing (for
comparison, the intensity of reflected beam
decreases as $\Delta\theta^{-2}$). The birefringence and di-
chroism are given by the real and imaginary
parts of $\Delta n_\sigma-\Delta n_\pi$ respectively (usually,
$|Re(\Delta n_\sigma-\Delta n_\pi)|{\gg}|Im(\Delta n_\sigma-\Delta n_\pi)|$). Note that dif-
fraction dichroism is connected with the
"tails" of anomalouse absorption because it
is proportional to $Im(\hat{X}_H\hat{X}_{\bar{H}})$.
The parameters of the X-ray quarter-wave
plate are calculated for different crystals.
It is shown that due to absorption only light
element crystals may be used for transformati-
ons of X-ray polarization. For the III reflec-
tion in diamond the angle $\Delta\theta$, optimal for the
polarization transformation, varies from I' to
10'' if λ changes from 3 Å to 0.5 Å respective-
ly (V.E.Dmitrienko and V.A.Belyakov (1980),
Pis'ma v Zh. Tekhnich. Fiziki, 6, 1440). In
this case the intensity of Bragg-reflected
wave is negligible (less than 1%) and absorp-
tion is not large ($\mu L=1$; μ is the absorption
coefficient and L is the plate thickness).
The discussed here off-Bragg quarter-wave
plate may be useful for the transformation
of the linear polarization of synchrotron
radiation into circular one. Note also that
measurements of Δn_σ and Δn_π outside the Bragg
reflection bands may, in principle, be used
for extinction free determination of struc-
ture amplitudes.

11.6-07   OPTICAL ACTIVITY AND THE FARADAY EFFECT AT
X-RAY FREQUENCIES. By M. Hart and A. R. D. Rodrigues*,
Wheatstone Laboratory, King's College, Strand, London
WC2R 2LS, UK.

During the last three years considerable progress has
been made in developing methods and making measurements
of X-ray optical polarization effects (M. Hart, Phil.
Mag., (1978) B38, 41, M. Hart and A. R. D. Rodrigues,
Phil. Mag., (1979) B40, 149).

Initial experiments investigated linear and circular
birefringence and dichroism. In the experiments which
we present here, we have re-examined optical activity in
quartz and made systematic measurements on Nickel sul-
phate hexahydrate paying careful attention to the system-
atic elimination of Bragg reflections. Earlier results
which purported to show the effects of optical activity
in silicon (G. G. Cohen and M. Kuriyama, Phys. Rev. Lett.
(1978) 40, 957), are re-interpreted in terms of well
known Bragg reflection phenomena.

We will report measurements of the Faraday effect in
nickel, cobalt, iron and beryllium which give upper
bounds of $5°cm^{-1}$, $50°cm^{-1}$, $50°cm^{-1}$ and $0.08°cm^{-1}$
respectively using $CuK\alpha_1$ radiation. These values are
typically 10 times smaller than the values expected on
classical theories. Further work is planned at synchro-
tron radiation sources where the X-ray wavelength can be
chosen to be very close to the appropriate absorption
edges and where much higher intensities can be achieved
with both linearly and circularly polarized X-ray beams.

* Present address:

Departamento de Fisica, Universidade Federal do Parana,
Curitiba, Brazil.