second type consists of mobile damage centers which congregate along existing imperfections. The first type can be either microscopically reversible or irreversible. As there is no evidence from our measurements that the damage in KDP extends beyond the unit-cell level it is classified as microscopically reversible local damage. This type is not expected to have as great a tendency to clamp existing domain structure into a crystal during irradiation. This is consistent with our ability to reverse the polarization. In addition there would be no tendency for the damage to internally bias the crystal. Of course, nonparamagnetic damage centers cannot be detected in our experiment and if these exist they may have an additional influence on the ferroelectric properties of the irradiated crystal.

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[†] Who is expected to present a dissertation containing this work to the faculty and graduate school of Clark University in partial fulfillment of the requirements for a Ph.D. in Physics.

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MEASUREMENT OF PHOTOABSORPTION OF THE LITHIUM HALIDES NEAR THE LITHIUM *K* EDGE

R. Haensel, C. Kunz, and B. Sonntag
Physikalisches Staatsinstitut, II. Institut für Experimentalphysik
der Universität Hamburg, Hamburg, Germany, and
Deutsches Elektronen-Synchrotron, Hamburg, Germany
(Received 2 January 1968)

Most of the work on optical absorption of alkali halides has been performed in the fundamental absorption region and gives information about transitions from p-like valence-band states to s- and d-like conduction-band states.[1] The investigation of transitions from s-symmetry core states (e.g., K shells) to p-like conduction-band states should give additional information. We have measured fine structure of photoabsorption in LiF, LiCl, LiBr, and LiI near the Li K edge (photon energy $\sim$60 eV). Such measurements have been reported only for LiF by Lukirskii *et al.*[2] For all Li halides some of the most prominent structure has been measured in electron energy-loss experiments by Creuzburg.[3]

We used the continuous spectrum of synchrotron radiation at the 6-GeV Deutsches Elektronen-Synchrotron as a light source.[4] The samples were mounted between the synchrotron and a grazing-incidence, scanning-type spectrometer with a resolution of 0.1 eV at 60-eV photon energy. The samples were evaporated *in situ* from molybdenum boats onto Al films of 1000 to 2000 Å thickness. For measurements at energies below the Al $L_{2,3}$ edge (73 eV), these Al films serve not only as substrates but also as filters to reduce the influence of higher order reflections of the grating.

Figure 1 shows the spectral dependence of the absorption coefficient of the lithium halides. As film thickness was not determined, no absolute values are given. The peaks are labeled with capital letters beginning at the onset of absorption. The positions of the maxima are given in Table I. The values are compared with the optical measurements in LiF by Lukirskii *et al.*[2] The agreement is excellent for the most prominent peak (B), but less ideal for the others. The peaks found in electron

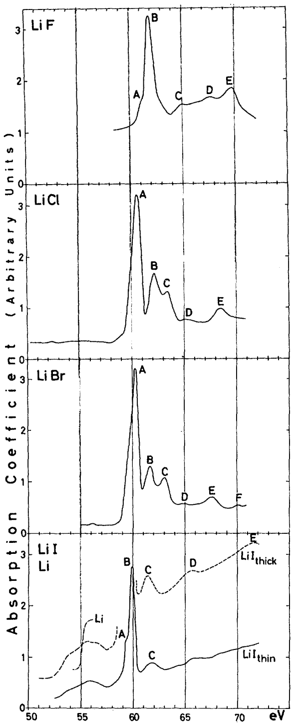

FIG. 1. Spectral dependence of the photoabsorption of the lithium halides. The absorption of metallic lithium is given near the K edge.

Table I. Position of the peaks in the absorption spectra of the lithium halides. The position is given in eV.

Maximum		Present study	Lukirskii et al.[a]	Electron energy loss[b]
LiF	A	61.13 ± 0.07		
	B	61.91 ± 0.07	61.9	62.00
	C	64.9 ± 0.15	65.1	63.00
	D	67.4 ± 0.15	68.4	
	E	69.6 ± 0.15	70.1	
LiCl	A	60.75 ± 0.07		60.65
	B	62.27 ± 0.07		62.1
	C	63.54 ± 0.07		63.5
	D	65.4 ± 0.15		
	E	68.8 ± 0.15		
LiBr	A	60.44 ± 0.07		60.30
	B	61.68 ± 0.07		61.5
	C	62.96 ± 0.07		62.8
	D	64.8 ± 0.15		
	E	67.7 ± 0.15		
	F	70.2 ± 0.15		
LiI	A	59.42 ± 0.07		
	B	59.82 ± 0.07		59.4
	C	61.5 ± 0.2		61.3
	D	65.6 ± 0.2		
	E	71.4 ± 0.2		

[a] Ref. 2

[b] Ref. 3.

energy-loss experiments on all the halides by Creuzburg[3] are in good agreement with our measurements with the exception of peak C in LiF.

There are some especially prominent peaks (Fig. 1) with a half-width of 0.5 to 1 eV at the onset of absorption. By analogy to transitions from the valence band at the onset of the fundamental absorption region,[1] we interpret these peaks as the result of exciton excitation. To each of these excitons there should belong an edge at higher energy which marks the onset of transitions into the respective band. We are not able to identify such edges in an unambiguous way.

Above the first prominent peaks we see a rich structure which might be related to the density of p-like states in the conduction band. The peaks labeled E in LiF, LiCl, and LiBr are especially characteristic. They are quite narrow and shift systematically from halide to halide. An unexpected feature is the anomalous structure at the lower energy side of peak A in LiI. This may be caused by the $N_{4,5}$ absorption of the iodine ion (see Bearden[5]), but another possibility is that it is caused by decomposition products, since LiI is known to decompose with irradiation.

The three exciton peaks (A, B, and C) of LiCl and LiBr show a remarkable similarity in the two materials, while there is only one prominent peak (B) in LiF and LiI. In both LiF and LiI there is a shoulder structure, which might be another hidden peak (A) at the low-energy side of the main peak. Notice that the lack of resolution is not an effect of our apparatus since the resolving power is 0.1 eV. The shape of this structure in LiF has been already observed.[2] We have also measured the LiF absorption spectrum with the film at liquid-N_2 temperature but no essential change in the structure was observed. The only change was a shift of the peaks by 0.2 eV to higher energies.

There are several possibilities to explain the width of the exciton peaks such as, for example, lifetime broadening due to exciton decay into continuum states and transitions from other states into the empty K level. To obtain some information about the contribution of the latter decay mechanism, we measured the spectrum of metallic lithium. Lithium was evaporated in normal high vacuum by surrounding the substrate film by a liquid-nitrogen cold trap. This retards oxidation, which is mainly due to the water vapor pressure as had been observed formerly.[6] The width of the observed edge (Fig. 1) is about 0.3 eV. This is in qualitative agreement with older results by Skinner and Johnston,[7] who have also remarked the final width of the edge. We thus believe that at least part of the width of the exciton peaks may be due to the limited lifetime of the empty K level, modified by the halogen ions.

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INTERACTIONS OF DISLOCATIONS WITH ELECTRONS IN METALS

C. Elbaum and A. Hikata
Brown University, Providence, Rhode Island

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Recently Hikata and Elbaum[1] reported experimental results on the interaction of moving dislocations with electrons in normal and in superconducting lead. One of their results was that in the normal state this interaction with electrons (or damping due to electrons) was independent of temperature, at least in the range investigated, i.e., $4.2 < T \lesssim 15^\circ$K. The fact that this interaction is temperature independent can be interpreted qualitatively as follows: A Fourier decomposition of the lattice displacements u associated with a dislocation[2] yields

$$u=\sum_q u_q e^{i\vec{q}\cdot\vec{r}}.$$

Each component u_q may then be treated as a "phonon" traveling through the lattice with the dislocation velocity v_d (v_d is much smaller than the velocity of sound in the solid v_s; typically $v_d \leqslant 10^{-2} v_s$) and the energy lost by these "phonons" to the conduction electrons can be determined using the established formalism of electron-phonon interactions.[2,3] It is important to note that, for example, the atomic displacements associated with an edge dislocation decrease rapidly with distance from the dislocation core (at a distance from the core of the order of five atomic diameters, these displacements become comparable with the amplitude of thermal phonons near the Debye temperature θ_D), and that they are substantially temperature independent (their temperature dependence is of the order of the thermal expansion of the solid). It follows that the components u_q dominant in the interaction with electrons have magnitudes of the wave vector q ranging from approximately the reciprocal of the lattice spacing to the reciprocal of about 10 lattice spacings, i.e., $10^7 \lesssim |q| \lesssim 10^8$ cm^{-1}. Thus, for most temperatures of interest and certainly in the range $T \lesssim \theta_D$ these magnitudes of q correspond to the condition $ql_e \gg 1$, where l_e is the electron mean free path. It follows that the interaction of dislocations with conduction electrons should be treated in the spirit $ql_e \gg 1$ and is, therefore, independent of l_e.[2,4,5] Since $\vec{q}$ as well as the dislocation density are also temperature independent, the interaction process is temperature independent.

In another recent publication[6] Huffman and Louat presented results of a calculation of the dislocation-electron interaction which indicate a temperature dependence equal to that of the electrical conductivity.[7] These authors also propose that the temperature dependence of the mechanical yield stress of a metal is determined by the (calculated) temperature dependence of the dislocation-electron interaction.

It is clear that these calculations are not