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## Light Scattering by Dislocations in Ionic Crystals

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A number of methods have been used to investigate the properties of lattice imperfections, i. e. the concentrations of vacancies and impurities and the structure of individual dislocations and dislocation nets. One of the most interesting and important methods is the direct microscopic observation of "colored" dislocations used by Amelincks (1956) with thin slabs of ionic crystals. Two other approaches have been X-ray diffraction (Dexter, 1953) and the estimation of vacancy concentrations by measurement of density and hardness changes upon deformation of the crystal (Vaughan, *et al.*, 1958). Other techniques have been used to get information about lattice imperfections, but none of these methods gives a complete picture of dislocations and dislocation nets in unperturbed crystals.

By means of a recent theory of light scattering (Theimer and Plint, 1958) and some recent experimental work (Sibley, 1957), it is now possible to estimate the concentration of bad regions, i. e. regions, in the neighborhood of dislocation lines, that contain an excess of vacancies or of impurity ions, the average vacancy or impurity concentrations and the dimensions of the bad regions. The shape of the bad regions also can be obtained by means of a Fourier analysis of the scattered light.

## EXPERIMENTAL

For incident light in the visible range a study can be made of dislocations and their associated fields in unperturbed crystals. It is found that the light scattering in ionic crystals is some ten times stronger than thermal scattering and violates Rayleigh's law of light scattering for small scattering units (Sibley, 1957). The light scattering of two Harshaw crystals, one of sodium chloride and one of potassium chloride, is found to be dependent on the orientation of the crystal with respect to the incident light direction. However, the scattering from several crystals, grown by the Navy Research Laboratory, appears to be independent of crystal orientation. This may be due to the fact that the Harshaw crystals have been annealed, whereas the NRL crystals have not.

For most orientations of the two Harshaw crystals the scattering follows Rayleigh's law to about 5600 angstrom units, falls to a minimum about 4800 angstrom units, and then tends to rise again slowly. The theory mentioned above (Theimer and Plint, 1958) shows that for deviations from Rayleigh's law at wavelengths below 5600 angstrom units the characteristic dimension of the scattering unit is approximately 2000 angstrom units. It may be noted that the potassium chloride crystal has an absolute magnitude of scattering power almost twice that of sodium chloride, even though the theory of thermal scattering predicts the same thermal scattering for both.

The dependence of the scattering power on the crystal orientation shows a striking regularity which is brought out most clearly by introducing a polaroid in the path of the scattered light, such that only the vertical component of the light is transmitted. It is found that large maxima occur in the scattering and move systematically as the orientation of the crystal is changed. When the crystallographic axes make an angle of about 13 degrees with the direction of the incident light the maxima on the left- and right-hand sides of the crystal are symmetric. This is true for both Harshaw sodium chloride and potassium chloride, but the crystals grown by the NRL show no maxima in the scattering power with angular variation.

The temperature dependence of the light scattering has been published elsewhere (Plint, *et al.*, 1958), but it is of interest to note that, although the wavelength and angular dependence of the Harshaw crystals appear to be the same except for the magnitude of the scattering power, their dependence on the temperature is different. Sodium chloride has a maximum in scattering power at about 275° K, and potassium chloride has a broad minimum in this range, but appears to approach a maximum at less than 180° K.

In order to eliminate surface scattering the crystals are immersed in a liquid of the same index of refraction. Triply-distilled benzene, which is known to obey Rayleigh's law, was used as an intensity standard and also to check the equipment.

## LITERATURE CITED

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