sites available for cracking.

It is worth noting that approximately 5% of the intergranular cracks are found to be pure secondary cracks (Fig. 1g and h). This clearly demonstrates that the triple points and TGI's are not necessarily the only nucleation sites for crack formation. The degree of cracking follows from triple point junctions, TGI, grain boundary, to twin boundary. It is interesting to note that the interfacial energies most likely also follow in that order.

Acknowledgement

This investigation was supported by the US Atomic Energy Commission under Contract AT(11-1)-2107. The authors are pleased to acknowledge the assistance of R. W. Swindeman, Oak Ridge National Laboratory, who kindly provided the tested specimens, their fabrication details, and the test results.

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Received 13 November
and accepted 25 November 1974

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A correlation between dielectric breakdown and mechanical strengths of alkali halides

Alkali halides represent a class of "simple" ionic solids which lend themselves to theoretical investigations attempting to correlate their fundamental properties, such as dielectric breakdown fields and mechanical strengths, with some of their basic parameters, e.g. chemical composition, magnitudes of electrostatic binding, lattice parameters and lattice energies. The purpose of the present note is to point out that the magnitudes of the experimental dielectric breakdown fields for alkali halides are directly related to their mechanical strengths as represented by their elastic modulii. The possible theoretical basis of this correlation will also be indicated.

The dielectric breakdown in an alkali halide is a field-induced phenomenon [1] and the parameter characteristic of the dielectric strength is thus the experimental value of the dielectric breakdown field; these values for various alkali halides have been critically reviewed [1] and used recently in another study [2]. The mechanical breakdown strength for a solid may be represented by the experimental value of its elastic modulus and the elastic modulii of alkali halides have been reported by Gilman [3]. The magnitudes of these two parameters for those alkali halides for which the data are available are given in Table I. A plot of dielectric breakdown fields against the elastic modulii shows a good straight line correlation (Fig. 1) in which high dielectric strength is associated with high mechanical strength. This correlation would tend to suggest that the basic factors determining the dielectric and mechanical strength for alkali halides are probably the same.

It has been shown recently [4] that the dielectric breakdown fields for these alkali halides (Table I) are inversely related to their lattice constants. Gilman [3] has shown that the elastic modulii of alkali halides are inversely related to their interatomic distances (lattice constant for an alkali halide is twice the interatomic distance between its constituent atoms). It is not surprising, therefore, that the dielectric breakdown fields for alkali halides are directly related to their elastic modulii (Fig. 1); it should perhaps be added that this rather important point has not

TABLE I

Compound	F_{exp} (MV cm^{-1})	Elastic modulus, C_{44} (10^2 dyn cm^{-2})
LiF	3.1	6.3
NaF	2.4	2.75
KF	1.9	1.25
NaCl	1.5	1.25
NaBr	0.81	0.95
KCl	1.0	0.65
RbCl	0.83	0.48
KBr	0.70	0.50
RbBr	0.63	0.38
KI	0.57	0.37
RbI	0.49	0.28

Notes: (1) The experimental dielectric breakdown values are from [1] and are not claimed to refer to single crystals. (2) The values of elastic modulus are from Gilman [3].

been explicitly brought out previously in the literature.

As regards the quantitative basis for Fig. 1, it should be noted that both the dielectric and the mechanical strength of an alkali halide is determined by its solid state cohesion. The solid state cohesion of ionic compounds such as alkali halides is represented by their lattice energy. One of the more direct procedures for the calculation of lattice energy of an ionic solid is provided by the Born equation [5]:

$$U = \frac{ANZ_1Z_2e^2}{R} - \frac{B}{R^m} \qquad (1)$$

where U is the magnitude of the solid state electrostatic cohesion, i.e. the lattice energy; A, B and m are constants; Z_1 and Z_2 are the charges on the ions constituting the lattice of an alkali halide so that $Z_1 = Z_2 = 1$; N is Avogadro's number; R is the inter-nuclear distance, i.e. the interatomic distance (R would thus be half the lattice constant); e is the electrostatic charge. Higher values of R would correspond to lower values of U and thence (in the light of the above arguments) lower values of dielectric breakdown fields and elastic modulii; on the basis of this fact and the evidence from [3] and [4] as quoted above, it becomes obvious that higher dielectric breakdown fields would be associated with higher elastic modulii (Fig. 1).

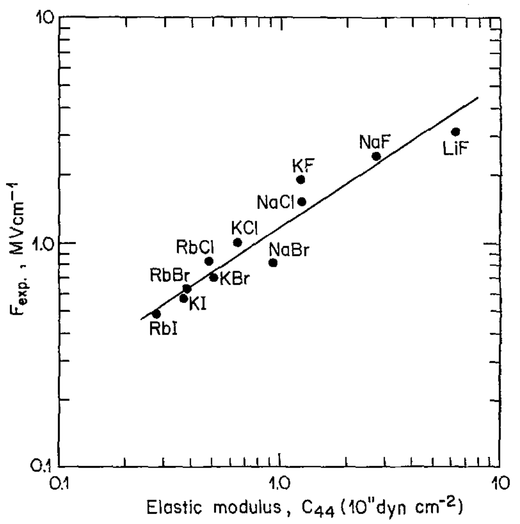

Figure 1 A correlation between the magnitudes of experimental dielectric breakdown fields and elastic modulii for the shown alkali halides; see Table I for details.

There is thus a direct correlation between the dielectric and mechanical strengths of alkali halides and the theoretical basis for this correlation is provided by a consideration of lattice constants, lattice energies and the electrostatic solid static cohesion in these predominantly ionic solids.

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Received 22 November
and accepted 28 November 1974

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