symmetrical (in the isotropic approximation). However, when a divalent cation impurity is introduced into the lattice, requirement of charge neutrality implies that a positive ion vacancy will be created. The resulting complex produces a non-symmetrical strain distortion with tetragonal symmetry. In view of Fleischer's conclusion that defects producing this type of distortion are the main contribution to hardening, this effect simplifies the detection and control of impurities in mechanical tests. In the present experiment, we found that magnesium was the principal divalent cation impurity.

A similar type of distortion results if LiF is irradiated with ionizing radiation. In this case, Nadeau[42,43,44] has shown that the tetragonal defect is created by an interstitial fluorine ion and its associated negative ion vacancy. The situation is illustrated in part (b) of Fig. 3.3. The negative ion vacancy has a positive charge with respect to the fluorine sublattice. This can bind an electron and form an F-center which may be detected by optical methods. Thus the defect concentration can be determined by optical absorption experiments.

The fact that these types of defects exert strong effects on yield stress obtained at low strain-rates has been well substantiated by experiment. In addition, it has been found experimentally that quasi-static yield stress varies approximately as the square root of defect concentration. There are various theories which predict this behavior. Johnston and Gilman[45] found experimentally that for a constant dislocation density and for a given applied strain-rate the dislocation velocity during yielding in LiF, was independent of the yield stress. They interpreted this to mean that yield stress was determined by dynamic resistance to dislocation motion. Thus two LiF crystals having different flow stresses have the same dislocation velocity (about

10^{-3} cm/sec) at the flow stress. In terms of Eq. (3.12), this implies that yield stress, Y, is related to the drag stress by a constant;

$$Y = KD \quad .$$

Or, in terms of Eq. (3.11), this can be written as

$$Y = KD_o C^{1/2} \tag{3.13}$$

where

$$D_o = \frac{\alpha\beta}{bkT}$$

For hardening due to impurities, the situation is somewhat complicated by the fact that impurities can cluster and hence affect both the drag stress in Eq. (3.11) and the concentrational dependence given in Eq. (3.13). In particular, Johnston[20] has demonstrated that the rate at which crystals are cooled from the annealing temperature strongly influences the state of aggregation and hence yield stress at low strain-rates. The effect has also been observed in various other alkali halides.[46,47,48] Although the magnitude of the effect varies for different materials, the general tendency is to increase yield stress as the state of association increases (for a fixed number of particles per volume). This dependence has also been observed in the present experiments for yield stresses obtained at low strain-rates. However, when dynamic and static data are compared, we will show that the effect produces different results for the two values of stain-rate employed here. This has important implications regarding the model of stress relaxation appropriate to precursor decay in LiF.

3.3. Dislocation Multiplication

In order to discuss precursor data reported in the next chapter, it is necessary to consider dislocation multiplication processes in the wave. There