ABSTRACT

Data are reported for shock wave propagation along a <100> crystallographic direction in single crystal lithium fluoride (LiF). Shock waves were obtained by impacting the specimens with an aluminum (6061-T6) projectile at a velocity of approximately 0.34 mm/μsec. The average initial stress produced at the impact surface was about 28.6 kbars.

Quartz gauges were used to measure attenuation of the elastic precursor for propagation distances ranging from about 0.25 mm to 15.5 mm. The maximum precursor amplitude observed in the study was approximately 21 kbars for a specimen 1 mm in thickness. A minimum value of about 2 kbars was observed for large propagation distances.

The present study shows that elastic precursor decay in LiF is critically dependent upon the presence of point defects. These were in the form of cation impurities in most of the specimens and were obtained through gamma radiation in others. For the observed range in concentration, yield stresses measured at low strain-rates varied monotonically with defect concentration from about 0.02 kbars for pure crystals to 1 kbar for the hardest material studied. Dynamic behavior was also strongly dependent on defect concentration. It was found that the corresponding precursor curves showed an initial rapid decay to an apparent equilibrium value of about 2 kbars for very soft crystals. The initial decay rate for hard crystals was also rapid, although the equilibrium stress was higher. However, a minimum in the decay rate was observed for materials which had an intermediate concentration of point defects.

Dynamic data are compared with those obtained at low strain-rate to show that dislocation processes are different for the two ranges of strain-rate employed. Present data suggest that dislocation multiplication controls precursor decay in LiF.

The study shows that multiplication behind the wavefront can account for at least half of the observed attenuation in materials which relax slowly. For materials which show a rapid decay, this effect is estimated to be approximately 10 to 30% of the total decay rate. A calculation is also presented which shows that multiplication in the wavefront can contribute significantly to the decay.