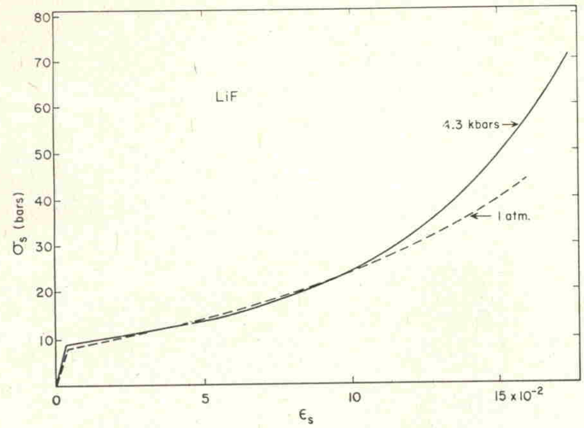

FIG. 3. Shear-stress–shear-strain curves for LiF at 1 atm and 4.3 kbar.

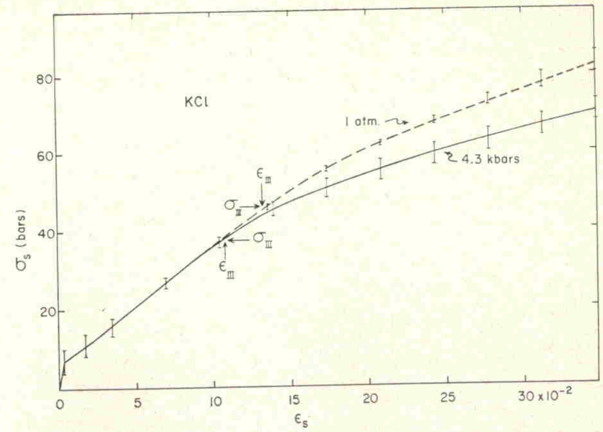

FIG. 5. Deformation of KCl at 1 atm and 4.3 kbar; the curve at each pressure represents an average for three specimens (average stress for a given strain). The error bars represent the maximum spread of the data; σ_{III} and ϵ_{III} are noted for each pressure.

A pressure-induced shortening of stage I is observed for LiF, NaCl, and KI and the same is probably true for KCl, where the scatter in the data is such that a single curve can represent the deformation in stages I and II at both pressures. The rate of work hardening in stage I appears little changed by the application of pressure except in KI where it is increased by roughly a factor of 2. The range of stage II, $(\epsilon_{III}-\epsilon_{II})$, is decreased by about a factor of 2 at 4.3 kbar in NaCl and KI and it is reduced slightly in KCl. The slope θ_{II} appears unchanged except in KI where it is doubled at 4.3 kbar. The length of stage II is reduced in extent in NaCl and KCl because σ_{III} is decreased by pressure; in NaCl σ_{III} decreases from $\sim$90 bars at 1 atm to $\sim$45 bars at 4.3 kbar and in KCl the reduction is from $\sim$45 bars to $\sim$40 bars. In KI, σ_{III} appears unchanged by pressure; $(\epsilon_{III}-\epsilon_{II})$ is reduced because of the increased slopes of stages I and II. Figure 4, for NaCl, shows that the 4.3-kbar σ–ϵ curve lies close to the 1-atm curve in stage I and above the 1-atm curve in stage II; it then crosses the 1-atm curve so that deformation proceeds in stage III at 4.3 kbar when stage II is still the stable deformation mode at 1 atm. At a strain where stage III is stable at both pressures, the rate of work hardening in KCl is less at 4.3 kbar (Fig. 5). The stage III curve for KI always lies at higher stress at 4.3 kbar (Fig. 6) and the rates of work hardening in stage III at 1 atm and 4.3 kbar are nearly the same.

Figure 7 shows an interrupted stress vs plastic strain, σ–ϵ_p, curve (the elastic strain is subtracted out) for NaCl deformed into stage II. The fractional change of flow stress with pressure (measured to the upper yield point on pressure application) is $\simeq 3\times 10^{-2}$, equivalent to the change which obtains in lightly deformed but heavily irradiated samples of NaCl.[2] A change of this magnitude may be accounted for by the change with pressure of the edge (K_e) and/or screw (K_s) dislocation stress-field constant in the NaCl structure. Figure 8 shows a 1-atm σ–ϵ_p curve for KCl interrupted twice in stage II and twice in stage III by deformation under pressure. For the first 4.3-kbar interruption in stage II, $\delta\sigma/\sigma \simeq 6\times 10^{-2}$ (on pressure application) and for the second, $\delta\sigma/\sigma \simeq 4\times 10^{-2}$, which is the same range of values found for γ-irradiated crystals and is approximately

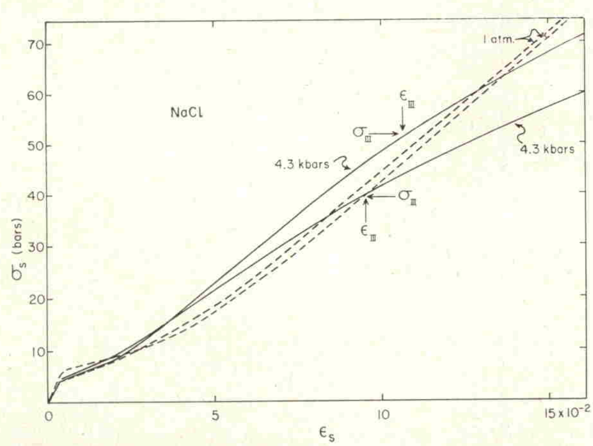

FIG. 4. Shear-stress–shear-strain curves for NaCl at 1 atm and 4.3 kbar. σ_{III} and ϵ_{III} are noted for the 4.3 kbar curves; σ_{III} at 1 atm is $\sim$90 bars.

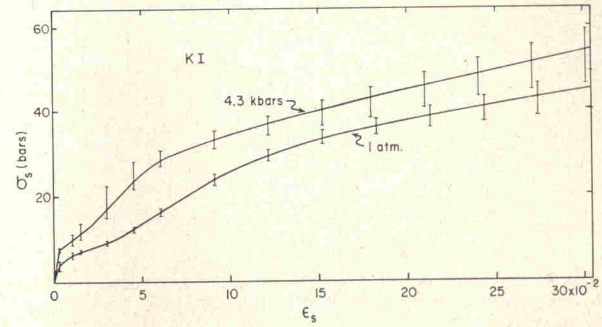

FIG. 6. Deformation of KI at 1 atm and 4.3 kbar; the curve at each pressure is an average for four samples. The error bars represented the maximum spread of the data.

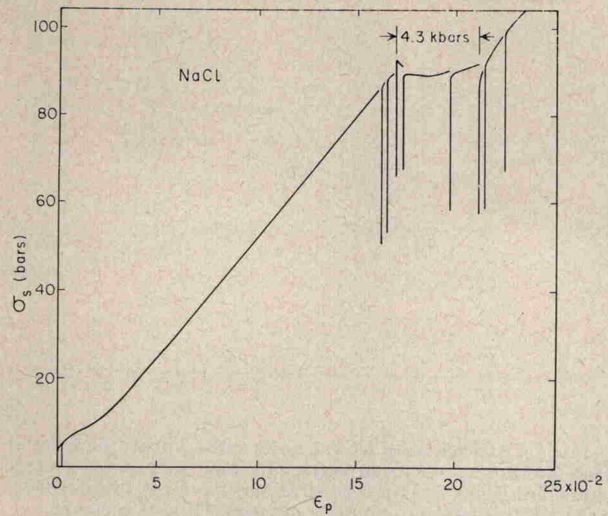

FIG. 7. An interrupted-stress–plastic-strain curve for NaCl prestrained well into stage II; $\delta\sigma/\sigma \simeq 3\times10^{-2}$ on pressure application.

equal to $\delta K/K$.[8] Figure 9, for KI, shows $\delta\sigma/\sigma \simeq 15\times10^{-2}$ in stage II; in LiF stage II yields $\delta\sigma/\sigma \simeq 1.5\times10^{-2}$. In all cases, $\delta\sigma/\sigma$ appears to be independent of strain in stage II, within experimental accuracy. Figure 10 shows a plot comparing $\ln(\sigma_2/\sigma_1)$ and $\ln(K_2/K_1)$ for alkali halides hardened by stage II deformation (or γ-irradiation[2]). These data are listed in Table II also.

The σ–ϵ curve for NaCl in Fig. 7 shows a pronounced yield point and reduced work-hardening rate when deformation is initiated at 4.3 kbar. This appears to be the same type of work softening as that observed by Cottrell and Stokes[1] in Al single crystals when deformation at low temperature was interrupted and then reinitiated at a higher temperature. Figure 8 for KCl, shows even more pronounced work softening in stage III, with the addition of a decrease of flow stress at high pressure; $\delta\sigma/\sigma$ is -6% on the second pressure interruption in stage III. Although some small-scale recovery is evident in the loading cycles just prior to pressure application, the observed decrease of flow stress at 4.3 kbar cannot be due to recovery because on pressure release the flow stress increases to its former value. The previous rate of work hardening also obtains after a short region of high work hardening rate. The occurrence of work softening in NaCl and KCl is evidence of plastic instability, i.e., the dislocation structure developed at 1 atm late in stage II or in stage III is unstable during deformation at 4.3 kbar because both σ_{III} and the rate of work hardening are less at this pressure. (Examination of the heavy strain regime in LiF is precluded by severe cracking.)

In an interrupted test there is apparently no significant irreversible, i.e., structure dependent, change in flow stress in stage II in NaCl and KCl. Within experi-

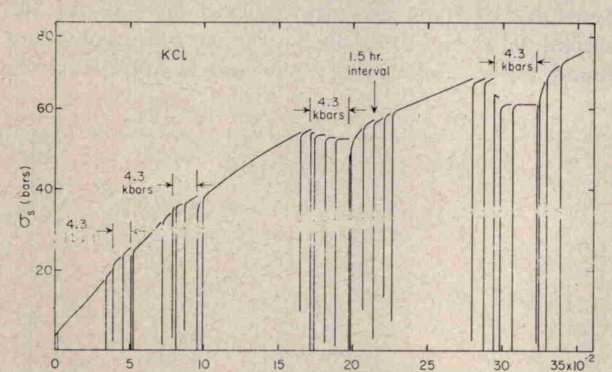

FIG. 8. An interrupted-stress vs plastic-strain curve for KCl. Two regions of high-pressure deformation obtain in both stage II and stage III.

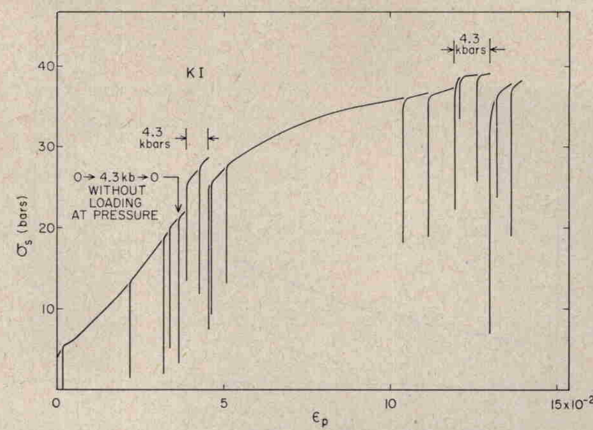

FIG. 9. A σ vs ϵ_p curve for KI interrupted once each in stage II and stage III where $\delta\sigma/\sigma$ (on pressure application) is $\simeq 15\times10^{-2}$ and 4×10^{-2} respectively. Note that a pressure cycle without loading at pressure causes no significant change of flow stress.

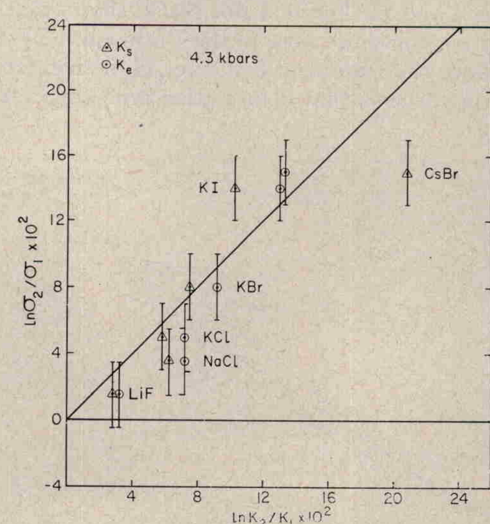

FIG. 10. A comparison of $\ln\sigma_2/\sigma_1$ and $\ln K_2/K_1$ for edge and screw dislocations, where subscript 2 refers to 4.3 kbar and 1 to 1 atm. $\ln\sigma_2/\sigma_1$ data for CsBr[2] and KBr (unpublished) are for γ-irradiation hardened samples. $\ln\sigma_2/\sigma_1$ data for the other materials are for stage II hardened samples; for γ-irradiation hardened samples $\ln\sigma_2/\sigma_1$ is virtually identical.

[8] Further experiments on irradiated crystals beyond those in Ref. 2 indicate a value of $\delta\sigma/\sigma \simeq 5\times10^{-2}$ for KCl, slightly lower than the value previously reported ($\delta\sigma/\sigma \simeq 8\times10^{-2}$).