promoting ductility through wavy slip, ductility will also be continually enhanced due to the suppression of cleavage by high pressure.

Application of pressure generally increases the flow stress of crystalline materials (Bridgman 1953). However, in NaCl polycrystals the reverse is found. Figure 4 shows that the flow stress for samples tested at 10 kb is less than at 1 atm (by some 20% at 5% compression). This difference falls well outside the range of experimental error. (The apparent increased work-hardening rate for sample No. 3 at large strain is due to the increasing sample area.)

§ 4. Discussion

4.1. *Single Crystal NaCl*

The nature of the mechanisms controlling the flow stress in stages I and II of deformation of NaCl is considered in a previous paper (Davis and Gordon 1969 a). We are primarily concerned here with $d\sigma_{\mathrm{III}}/dP$. Hesse (1965) has suggested that stress-assisted, thermally activated cross slip of extended slip dislocations controls σ during stage III deformation of NaCl. Observations of surface slip traces which support this conclusion are reported by Matucha and Haasen (1967). Fontaine (1968) has calculated the stacking-fault energy (γ) for $a/2\ \langle 110\rangle$ slip dislocations on $\{110\}$ planes; he shows that dissociation is accompanied by a considerable dilatation of the lattice in the vicinity of the stacking fault ($\delta d_{110}/d_{110} = \epsilon_0 \simeq 0{\cdot}3$). Fontaine and Haasen (1969) calculate the pressure dependence of the stacking-fault width, d, to be:

$$d/b = \frac{\mu b(1+\epsilon_0{}^2/4)}{2\pi(1-\nu)(\gamma_0+\epsilon_0 bP/2)}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where b is the Burgers vector, μ the shear modulus, γ_0 the stacking-fault energy at 1 atm and ν Poisson's ratio. As we are dealing with an anisotropic crystal, μ should be replaced by $K_{\mathrm{s}}(K_{\mathrm{e}})$ the screw (edge) dislocation stress field elastic constant in the NaCl structure or some average, K, of K_{s} and K_{e}. In eqn. (1), then, $K(\mu)$ and $\gamma(=\gamma_0+\epsilon_0 bP/2)$ are the most sensitive functions of P; on differentiation:

$$\Delta(d/b)/(d/b) \simeq \Delta K/K - \Delta\gamma/\gamma. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Because of the large value of ϵ_0 ($\sim 0{\cdot}3$) the increase in γ outweighs the increase in K, resulting in a net decrease in d/b; at 4·3 kb, $\Delta K/K \simeq 0{\cdot}07$. (Davis and Gordon 1968), $\Delta\gamma/\gamma \simeq 0{\cdot}14$, hence $\Delta(d/b)/(d/b) \simeq -0{\cdot}07$ (Davis and Gordon 1969 b). As K varies approximately linearly with pressure and $\epsilon_0 bP/2 \ll \gamma_0$, the decrease in d/b is approximately linear with P; a decrease in d/b facilitates the recombination of partial dislocations in the cross-slip process with a resulting decrease in σ_{III}. Cross slip is also believed to control stage III dynamic recovery in f.c.c. metal single crystals but Haasen and Lawson (1958) have shown that σ_{III} is not pressure sensitive in these materials. Thus if stacking faults, in fact, exist in NaCl (and stage III is cross-slip controlled) one must conclude that σ_{III} is pressure sensitive because of their dilatation.

Examination of eqn. (1) indicates that any dependence of $d\sigma_{\mathrm{III}}/dP$ on solute content at small concentrations based on the ‘ cross-slip ’ mechanism must arise through an impurity dependence of ϵ_0. If a linear proportionality between d/b and σ_{III} is assumed (d/b (eqn. (1)) and σ_{III} (fig. 2) both vary approximately linearly with pressure), a 30% change in s (the approximate difference in slope between lines X and Y in fig. 2) requires a corresponding 30% change in $\Delta(d/b)/(d/b)/\Delta P$; this is achieved by a 15% change in ϵ_0. At 1 atm the change in d/b due to a 15% change in ϵ_0 (through the $(1+\epsilon_0{}^2/4)$ term in eqn. (1)) is negligible ($\sim 0{\cdot}6\%$). Thus a moderate change in ϵ_0 may effect the pressure dependence of σ_{III} without causing a general shift of the σ–ϵ curve at 1 atm. This says, in effect, that the solute dependence of σ_{III} is greater at high pressure. While this must be a trace effect, it is known that mechanical properties of the alkali halides are very sensitive to small concentrations of polyvalent impurities (Johnston 1961). As one would expect that σ_{III} is increased by solute addition, it would appear that line Y ($s \simeq -10\%/\mathrm{kb}$) corresponds more closely to pure NaCl.

If stacking faults do not exist in the alkali halides, an alternative explanation of the reduction of σ_{III} with P is necessary. Perhaps stage III dynamic recovery is controlled by the ‘ cube-slip ’ mechanism, i.e. stage III begins when local stress concentrations become intense enough to force slip on $\{100\}$. This, in effect, is also cross slip but it does not involve recombination of partial dislocations as the rate-limiting step. A decrease in σ_{III} based on the cube-slip mechanism requires the ratio of σ_{100} to σ_{110} to be reduced by pressure; according to Dommerich (1934) $\sigma_{100}/\sigma_{110} \simeq 3$ at atm and room temperature. As σ_{110} does not increase greatly with P (an interrupted test, i.e. pressure cycling, indicates about a 10% increase in σ at 7 kb in stage II), this would require a marked, pressure-induced decrease in σ_{100}. This seems most unlikely since then the activation volume for $\{100\}$ slip would be negative. (Note that σ_{III} is not associated with the stress to move dislocations on a particular plane but rather it signals the development of the cross-slip structure; hence negative $d\sigma_{\mathrm{III}}/dP$ does not imply a negative activation volume.) Preliminary investigations in our laboratory indicate, in fact, that $d\sigma_{100}/dP \simeq 0$. Therefore, reduction of σ_{III} with P due to reduction of the ratio $\sigma_{100}/\sigma_{110}$ appears unlikely; some mechanism other than cube slip must control stage III if, in fact, it is not cross-slip controlled.

4.2. *Polycrystalline NaCl*

The reduced flow stress of the NaCl polycrystals at 10 kb correlates with the reduction of σ_{III} with P in single crystals; the same mechanism, i.e. the increased ease of cross slip at high pressure, is believed to account for both reductions. Increased cross slip will lead to the wavy slip microstructure observed for samples deformed at high pressure. As discussed