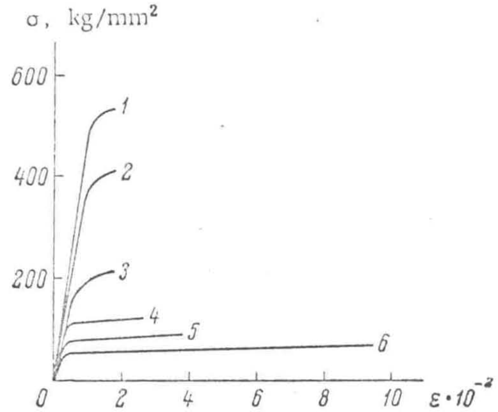

Fig. 3. Stress-strain curves for beryllium single crystals compressed along their hexagonal axes. Temperature (°K): 1) 4.2; 2) 77; 3) 300; 4) 500; 5) 700; 6) 900.

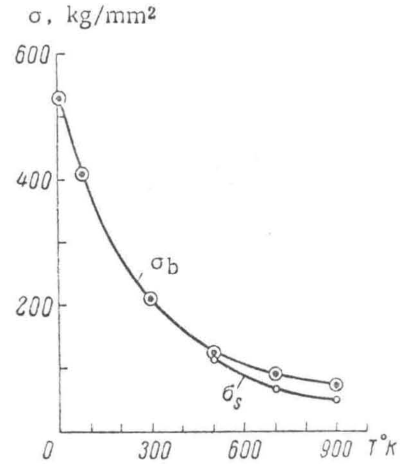

Fig. 4. Temperature dependence of the compressive strength σ_b and the yield point σ_s of beryllium single crystals on compression at right angles to the basal plane (0001).

atures, the $\sigma_b(T)$ curve is monotonic. The $\sigma_s(T)$ curve has physical meaning only from the temperature at which considerable shear appears along certain crystallographic planes. Therefore in Fig. 4 the $\sigma_s(T)$ curve joins the $\sigma_b(T)$ curve in the temperature range 300-500°K.

Since optical and electron-microscopic studies of the surfaces of the crystals deformed in steps showed no traces of slip or twinning, the slight plastic deformation preceding fracture at low temperatures is obviously due to processes of block formation occurring immediately before fracture.

High stresses, close to the compressive strength, are necessary to fragment the single-crystal structure (formation of blocks), as indicated by the following observations:

1) up to stresses close to the compressive strength the sample recovered fully its original dimensions after unloading;

2) on reaching the maximum (breaking) stress the crystals fractured instantaneously, disintegrating into very small particles.

The main dimensions of the particles obtained on fracture of beryllium single crystals increased with rising temperature from $\overline{d}$ = 1-2 μ at T = 4.2°K to 100 μ at 300°K.

Figure 5 shows photomicrographs of the particles formed on fracture of beryllium single crystals. We see that micron size particles formed by low-temperature fracture do not have definite crystallographic habit, in contrast to fracture blocks of the single crystals at room temperature. Irregular surfaces of the fragments formed in low-temperature fracture may be the result of a change in the ratio of the crystallographic axes c/a due to deep cooling. In such a case the linear expansion should be very strongly anisotropic.† Moreover, considering the process of crack formation as the accumulation of dislocations [13], we may conclude that the low mobility of dislocations at low temperature impedes crack growth; the fracture surfaces are conchoidal with a large number of crack nuclei which have hardly grown. This also leads to a rise of σ_b. We may assume that an increase of temperature not only lowers the limit of block formation but also makes the fracture surfaces more crystalline. However, in spite of the more pronounced crystalline nature of fracture no traces of deformation were found in the fracture planes. This is a further proof of the nonshear nature of the residual deformation found on fracture of beryllium single crystals in the temperature region 4.2-300°K. The assignment of indices to the fractured planes indicates that microcracks appear and propagate in the second-order prismatic planes $\{11\bar{2}0\}$, basal planes (0001) and second-order pyramidal planes $\{11\bar{2}1\}$.

3. Discussion of Results

A. High Strength of Beryllium Single Crystals of Given Orientation

Comparison of the results given in Tables 1 and 2 shows that in a wide range of temperatures the value of the maximum fracture stress of beryllium single crystals of the given orientation (α = 90°) exceeds by a factor of 10 the value of the compressive strength σ_b of beryllium single crystals oriented favorably for basal slip (α = 45°). In this case the orientation dependence (anisotropy) of the compressive strength is more important, since the temperature dependence of the maximum fracture stress is approximately the same for different orientations.

The high value of the compressive strength of beryllium single crystals of the given orientation, particularly at low temperatures, is due to practically the whole of the prefracture deformation being elastic. There is no plastic deformation in the principal crystallographic planes and, therefore, the generation of fracture nuclei during loading is avoided.

† Information is available indicating a rise of c/a on lowering the temperature in the region 0-1000°C [7].