effect but it is probable that it will produce a net tensile stress component normal to the craze tip.

An estimate of the craze initiation stress may be made using classical elasticity theory [6] and taking into account the finite width of the specimen. Tensile samples of the same cross-sectional dimensions as the compressive ones were also tested at a strain rate of 10^{-2} sec^{-1} and crazing occurred at a net section stress of 49 MN m^{-2}. Crazes originated from the ends of the horizontal diameter and the samples fractured due to crack propagation through the crazes. The maximum tensile stress in the sample at craze initiation was approximately the same as that for initiation under applied compression.

When compressive specimens were examined after testing it was observed that in some cases further crazes had formed at the ends of the horizontal diameter as indicated at B in the figure. This crazed region is associated with compressive stresses on loading but further experiments showed that horizontal crazes occurred on unloading. Their growth is therefore attributed to the presence of tensile residual stresses and it is noted that Kramer [7] detected non-Hookean (anelastic and plastic) deformation when he compressed notched samples in his study of shear-banding polystyrene. The maximum residual tensile stress in the present tests is normal to the craze plane at initiation and the local stress field is dilational. This phenomenon does not occur consistently even when the applied stress approaches that at the load maximum. It is associated with cyclic rather than monotonic loading and work is in progress to study the effect of load cycling. Experiments have been carried out in fluctuating compression with a lower limit of zero and various upper limits, in the range 80 MN m^{-2} to 110 MN m^{-2} net section stress, and horizontal crazes have been produced in all tests.

It was difficult to detect the formation of shear bands but they were observed on crazed specimens as shown by C in the figure. Supplementary experiments were carried out in which samples were loaded to pre-determined levels and were viewed after unloading. When shear bands were obtained they were clearly visible on tilting the specimen slightly from the vertical plane. The net section stress for shear band initiation was found to be 116 MN m^{-2}.

The present experiments indicate that the hypothesis that the local stress field is dilational at craze initiation is plausible and they demonstrate the desirability of taking local stresses into account wherever possible. The work is being extended to investigate environmental effects.

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Direct observation of the polytype periodicities in the Be–Si–O–N system

A new class of polytypism, in which the unit cell is determined by the composition rather than by a periodicity of displacement faulting, has been reported to occur in the so-called "Sialon" ceramics [1]. The purpose of this note is to present direct lattice fringe observations of polytypism in one such ceramic, the Be–Si–O–N system.

The polytypes were first reported to occur near the AlN corner of the Si–Al–O–N system [2], but structurally similar ones have since been found in the Be–Si–O–N, Mg–Si–Al–O–N, and Li–Si–Al–O–N systems [3]. In all these alloy systems

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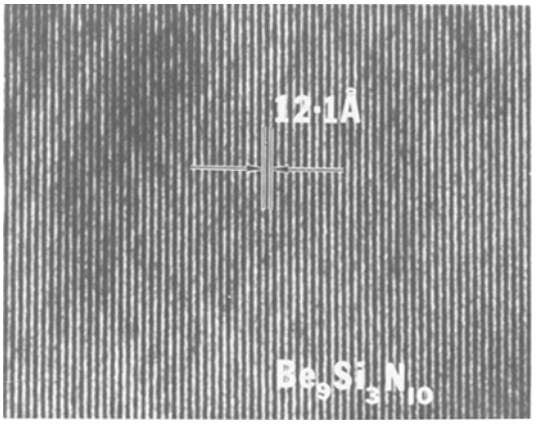

Figure 1 Direct resolution of the block spacing (12.1 Å) of the 15R polytype.

there are a series of crystalline phases having narrow ranges of homogeneity extending along lines of constant metal: non-metal atom ratios, which have been interpretated on the basis of X-ray powder diffraction as wurtzite polytypes. In the Be–Si–O–N– system, the polytypes are in the Be_3N_2 rich region. They occur for metal: non-metal atom ratios of $M_{m+1}X_m$ where the minimum value, $m = 2$, corresponds to β-Be_3N_2 which has the polytype designation 4H (Ramsdell notation) and the maximum value $m = \infty$ (MX) corresponds to ordered wurtzite $BeSiN_2$ [1].

Polytypism in these systems is attributed to the insertion at regular intervals of a cubic stacked M_2X layer into the MX layer arrangement of the wurtzite structure. The spacing between these M_2X layers is determined by the overall composition. Using the notation of Thompson [1], the non-metal atom stacking in β-Be_3N_2 (M_3X_2) consists of a close packed layer sequence

$$A_m^m B^m C_m^m B^m A_m^m B^m C$$

with alternate M_2X and MX layers. Similiarly, the atom stacking in $Be_9Si_3N_{10}$, (M_6X_5) consists of a close packed layer sequence, 15R,

$$A_m^m C^m A^m C^m A^m C_m^m B^m C^m B^m C^m B_m^m A^m B^m A^m B^m A_m^m$$

in which the M_2X layer is inserted every fifth layer. The unit cell of this structure then consists of three rhombohedrally related blocks each of which contains five close-packed layers.

Using the technique of direct lattice fringe imaging in the transmission electron microscope we have been able directly to observe and confirm this structure. In Fig. 1 the periodicity corresponding to the polytype block spacing 12.1 Å has been imaged, and the selected area electron diffraction pattern of the same area is presented in Fig. 2. The rhombohedral symmetry of this (0 1 . 0) diffraction pattern and the five regularly spaced spots between the transmitted beam and that corresponding to the close-packed spacing (marked 15) indicate that the area has the 15R structure. The lattice fringe image of Fig. 3, in which the individual close packed layers have been recorded, graphically confirms the suggestion of Thompson [1] that

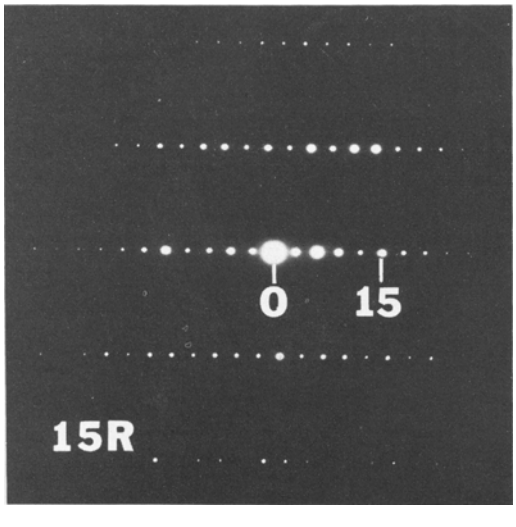

Figure 2 Selected area electron diffraction pattern of the (0 1 . 0) reciprocal-lattice plane showing the $h\,0\,.\,l$ rows. The symmetry and spacing of the spots indicates that the area has the 15R structure.

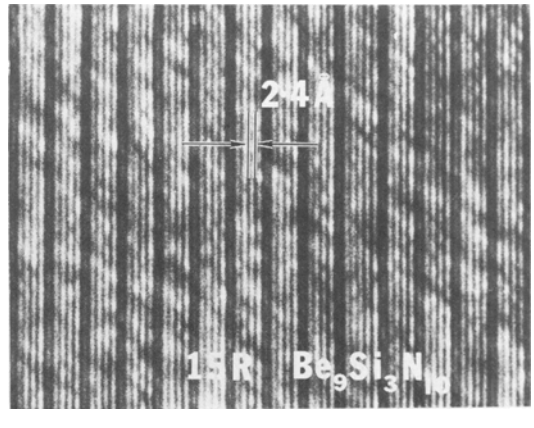

Figure 3 Direct lattice fringe image in which the individual close planes (2.4 Å) can be seen. In this relatively perfect region each block consists of five close-packed planes.

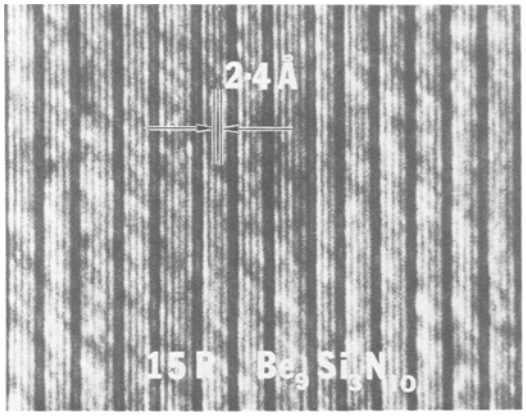

Figure 4 An adjacent region to that of Fig. 3. Departures form the ideal polytype arrangement are seen directly with some blocks comprising only four close-packed planes and others.

the unit cell consists of three symmetry related blocks of five close-packed layers. Similar results have been found in the Mg–Si–Al–O–N System where the metal: non-metal atom ratios are M_mX_{m+1}.

Observing the close-packed planes also allows departures from the ideal polytype arrangement to be examined directly. An example of this is shown in Fig. 4. Here, although the electron diffraction pattern again indicates an overall 15R structure there are faults in the block structure and instead of comprising five planes some of the blocks have six and others only four. By incorporating such faults the local composition varies from the exact $Be_9Si_3N_{10}$ composition. Very large variations in composition may occur in this manner, and a later publication will present detailed evidence for the resulting structures.

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The estimation of the diffusion coefficient of oxygen in Cr_2O_3 from creep measurements

Chromium oxide plays an important role in the oxidation resistance of many steels. It is rapidly formed on the surface of the steel during service and provides a barrier to further oxidation between the metal and oxidant. The efficiency of this barrier depends on a number of factors such as the degree of adhesion between the oxide and the metal, the mechanical properties of the oxide and the diffusion coefficients of chromium and oxygen in the oxide. No creep data are available for chromium oxide and the present investigation was undertaken to provide such information. Additionally, it was intended to investigate creep in the region where creep is controlled by the stress-directed diffusion of vacancies (Nabarro–Herring creep) such that estimates of diffusion coefficients could be made from creep rates. NH creep depends on the migration of vacancies from grain boundaries stressed in tension to those under compression. The rate of creep $\dot{e}$, originally pre-

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