this application*. This circuit offers the following features:

1. Regulated power supply to drive the transducers (from points a and b) and the zero offset circuit†.

2. A passive voltage divider network across the input, points c and d, with an input impedance of 20 kΩ and a "gain" variable between 0.25 and 0.75.

3. A zero offset facility which allows the zero to be set electrically and which can be adjusted so that the output is positive going (or vice versa) for the whole range of the transducer.

4. In the switch positions shown in Fig. 2, two independent outputs, RH and LH, are available at the output sockets 1, 2 and 3, 4 respectively for monitoring the two sides of a specimen independently.

5. Alternatively a differential signal may be obtained by using sockets 1 and 3.

6. A sum signal may be obtained by reversing the RH with respect to the LH channel and again using sockets 1 and 3. The mean is obviously obtained by halving this signal.

7. The output may be fed directly to most standard, high input-impedance, multirange millivolt recorders giving effectively an instrument with a full scale of between 200 and 10^5 microstrain. Alternatively the signals may be fed to an analogue to digital logging system whereupon the digital record on paper or magnetic tape can be analysed directly by a computer.

In conclusion, the system has been found to meet all the performance criteria set out in the first two paragraphs of this letter for static testing of composite materials. For dynamic testing, the inertia of the moving parts would restrict it to frequencies of less than 5 Hz. The system is cheaper by a factor of about three and more versatile than a commercially available extensometer‡ of similar range and sensitivity provided appropriate recording equipment is already available.

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*Alternative units are available from Sangamo-Weston Controls Ltd.
‡Coutant type KD 100/18/6.
†Supplied by Instron Ltd.

Extended basal plane shear in pyrolytic graphite at 3035 K

Pyrolytic graphite in the as-deposited state has a structure of basal plane layers which are parallel to but randomly rotated from neighbouring layers [1], a structure called "turbostratic." When heated above 2800 K, or heated and deformed parallel to the deposition plane (roughly parallel to the basal planes), this structure "graphitizes," i.e. crystal perfection within crystallites increases and unit cell height decreases; simultaneously, misorientations between crystallites decrease and preferred orientation increases. The combined processes have been likened to straightening a stack of wrinkled sheets [2].

For deformation at temperatures near 3000 K, the dewrinkling process occupies about the first 10% strain [3, 4], and has been called "first stage" deformation [3-6]. When 10% strain is reached, then, the basal planes are relatively well aligned with the tensile axis and further deformation occurs by different mechanisms [3, 4, 6, 7]. It would be of interest, however, to examine the process of shear on the basal planes after dewrinkling is complete. This communication

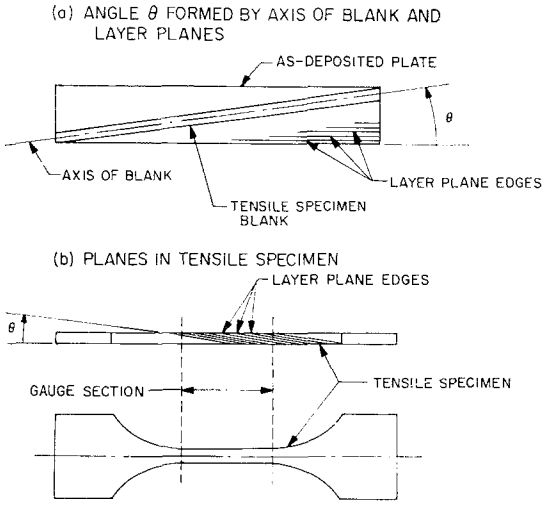

Figure 1 Preparation of specimens for basal shear testing (a) Relation of specimen blank to as-deposited plate. (b) Basal layer planes at angle θ in finished specimen.

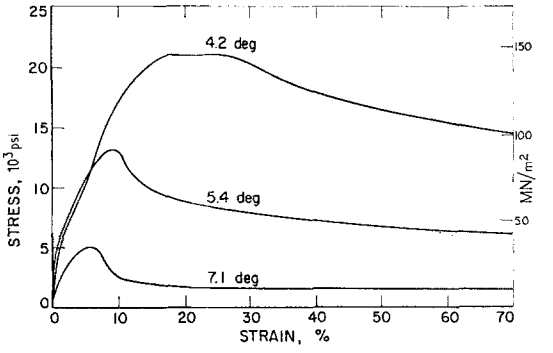

Figure 2 Tensile true stress-true strain curves at 3035 K for specimens of pyrolytic graphite with basal planes at three angles θ to tensile axis.

describes a technique for doing so, and briefly presents results of tests using the technique.

Flat tensile specimens were cut from as-deposited blocks of substrate-nucleated pyrolytic graphite [3]; these specimens were 2.5 mm thick and had a gauge section 2 mm wide and 19 mm long. The important point, as shown in Fig. 1, is that specimens were oriented with the tensile axis at an angle θ to the basal plane layers. This orientation permitted basal shear to continue after dewrinkling was complete, as will be described. The specimens were inserted into grips which had a loading surface along the specimen shoulders (Fig. 1b) and tensile tested in the apparatus described previously [8]. High temperatures were attained by radiation from a separate resistance-heated graphite element, and were measured with a disappearing-filament optical pyrometer. Tests were performed in a helium atmosphere at 3035 K, with an initial strain-rate of 2×10^{-4} sec^{-1}.

Stress-strain curves for specimens cut at three different angles are shown in Fig. 2. The initial rising portion of each curve evidently corresponds [3, 7] to the dewrinkling process, which occurs at lower strain as the resolved shear stress on the basal planes increases with θ. Subsequent deformation takes place by shear on the basal planes at a lower stress [3]. As θ increases, "free" basal layers (layers which lie through the thickness without entering the shoulder section at either end) come into existence. The specimen geometry provides "free" layers only for $\theta > 7°$; this is consistent with Fig. 2, which suggests that $\theta < 7°$ results in deformation beyond 10% strain by mixed basal shear and continued dewrinkling of a widening "nearly free" zone. The resolved shear stress, τ, for steady basal flow in the 7.1° specimen of Fig. 2, and others not shown,

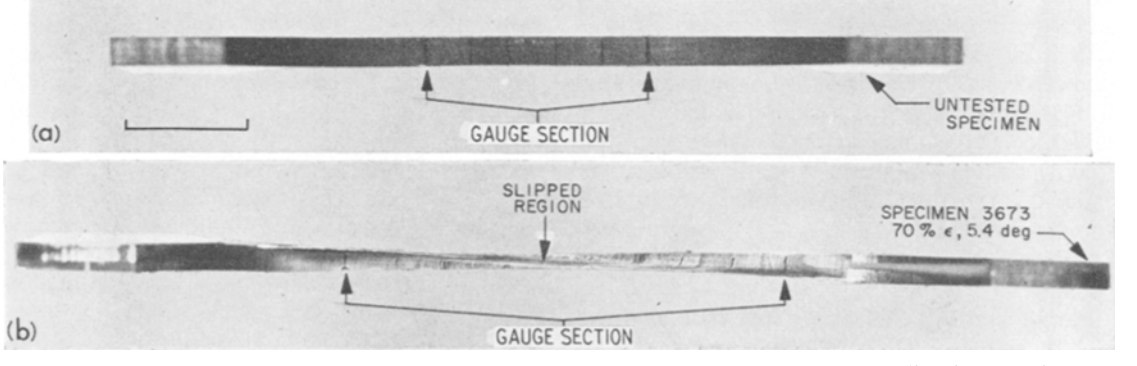

Figure 3 Shear morphology in specimens. (a) Untested specimen with scribe marks; scale line is 1 cm long. (b) Specimen extended 70%, showing slipped zone; magnification same as (a).

averaged 1.53 MN m^{-2}. This is in satisfactory agreement with $\tau = 1.72$ MN m^{-2} for a specimen with $\theta = 12°$ [3].

The appearance of specimens after testing was consistent with the above description. For example, in a specimen with $\theta = 5.4°$ the zone of deformation is readily detected (Fig. 3); scribes on the gauge section are characteristically curved at the edges of the slipped zone. Elongation, such as that shown in Fig. 3, took place entirely by thickness reduction, with no change in specimen width. Such behaviour is consistent with the attribution of deformation to basal plane shear processes. A specimen with $\theta = 7.1°$ was pulled to failure, which as expected occurred by shearing off of basal layers in the deformation zone. True strain at failure was 210%.

In summary, the technique of cutting tensile specimens at an angle to the basal planes produces extensive basal shear in pyrolytic graphite at 3035 K. For the specimen geometry described, the angle θ must exceed about 7° for this observation to be made. The resolved shear stress for basal flow was observed to be about 1.5 MN m^{-2}, and the evidence of Figs. 2 and 3 would be consistent with the suggestion [3, 4, 7] that this shear occurs by glide of basal dislocations, assisted by diffusional processes.

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Contribution of dissolved or precipitated oxygen to the electrical resistivity of vanadium

It is widely said that the so-called stage III "recovery" of body-centred cubic metals originates in the existence of impurity interstitials [1-5], although some investigators have pointed out the importance of the role of intrinsic defects produced by irradiation or cold-work [5, 6]. Recently, for neutron-irradiated vanadium, Stanley *et al.* [4] have concluded that the decrease in resistivity of 3.2 μΩ-cm (at. %)$^{-1}$ after annealing results from the precipitation of impurity interstitials at the radiation-produced defects. In their experiments, this value was about 36% of the resistivity increase caused by the dissolution of 1 at. % of impurity interstitials. From this fact, it is expected that in the case of cold-worked specimen, the decrease in resistivity due to ageing or annealing treatments must also considerably differ in amount from the increase due to dissolution of the oxygen atom. The purpose of this paper is to investigate the difference in the resistivity changes caused by dissolved and strain-aged oxygen in vanadium.

The starting material was electron-beam melted polycrystalline vanadium. Chemical analysis showed that gas impurity content of the material was as follows: oxygen 310 to 2000; nitrogen 15; carbon 130; hydrogen 5 (ppm by weight). Wire specimens, 0.5 to 0.8 mm in diameter, were prepared using grooved rolls and a drawing machine. All the specimens were annealed at 900°C for 2 h in a vacuum of 2×10^{-6} mm Hg. Electrical resistivity was measured at liquid nitrogen temperature using a potentiometer. A measurement of the Snoek damping was made in a torsion pendulum at about 1 Hz with a strain amplitude of about 7×10^{-5}. Defects were introduced by cold-drawing for the ageing experiments.