Further studies of cavitation were made by carbon/platinum replicas taken from grain boundaries of specimens which had been deformed at 500° C and subsequently fractured at −196° C. Fig. 2 shows an example of the nucleation and growth of cavities at the intersection of the grain boundary by a sub-boundary. The cavities have a polyhedral morphology with some suggestion of terraced walls. A thorough analysis of the sites occupied by single cavities for both the α-iron and the iron–phosphorus alloy was carried out. Without exception, all the cavities were situated at grain boundary–sub-boundary intersections and from 350 observations, less than 3% were also associated with particles.

The influence of room temperature deformation and annealing at 500° C prior to creep-testing at 500° C on the formation of cavities was investigated. Such a procedure introduced a well established substructure into each material. For similar creep deformations, the presence of a prior substructure increased the number of observable grain boundary cavities by a factor of 2 and these were always associated with grain boundary–sub-boundary intersections.

Use was made of a 1 MV TEM to examine cavities at high magnifications wholly contained within the foils. Both materials were creep-tested in the annealed and pre-deformed conditions at 500° C. Figs. 3 and 4 are micrographs obtained from specimens prestrained at room temperature and deformed at 500° C to 0.3% and 0.9% strain respectively. In all the foils studied, cavities were situated at tilts in the grain boundary being accompanied by dislocation networks. Particles were also observed at the grain boundaries but were not necessarily associated with cavities.

In conclusion, the observations show that a grain boundary–sub-boundary intersection is a site for cavity nucleation in α-iron and iron–phosphorus alloys containing small volume fractions of second phase particles.

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Comments on "The preparation of an ultra-oriented polyethylene morphology"

A recent paper [1] describing the preparation of an ultra-oriented polyethylene morphology prompts us to comment upon the similarity of this recent work to previous work by ourselves to which reference has not been made.

Porter and co-workers have carried out pioneering studies on the deformation of polymers, as reported in a number of publications [2–5]. This recent paper [1] reports what is described as a new procedure for producing ultra-oriented polyethylene which differs materially from that originally developed by Porter and co-workers. Their present procedure is to reach an equilibrium crystallization and then "perform a solid-state extrusion rather than one in a highly viscous liquid state". We wish to point out that we have been using a similar procedure in our laboratories for several years.

We should perhaps also emphasise that we have not been concerned with deformation in highly viscous liquid states, and that those developments clearly predate our own studies which have been entirely based on deformation in the solid state.

Extrusion in the solid state is well documented in the literature, and can be achieved using either a piston–cylinder apparatus as described by the authors and others [6] or by the process of hydrostatic extrusion. The latter process is similar in principle to the piston–cylinder technique, the piston being replaced by a high pressure fluid which surrounds the deforming work piece. Hydrostatic extrusion has the advantage of decreasing the energy dissipated due to friction. We developed a solid-state extrusion process using the latter method for the production of ultra-high modulus polyethylene several years ago which was reported in this journal [7] in 1974. The process is also the subject of a provisional patent application [8].

Capiati *et al.* further remark that they have "developed a much more efficient and, importantly, essentially continuous method for producing high density polyethylene strands of extreme orientation". We wish to comment that continuous methods for the production of tapes and fibres of ultra-high modulus polyethylene by drawing were also developed in our laboratories some years ago, in addition to the hydrostatic extrusion method already discussed. This work has been extensively reported in the literature [9–16], and it has also been emphasized [12] that some of the key guidelines for the production of such materials by drawing, e.g. effect of molecular weight and crystallinization conditions, are applicable to solid-state extrusion. The similarity between the properties and structure of ultra-high modulus polyethylenes produced by solid-state extrusion and drawing is very great [7, 11, 15] because both are solid-state deformation processes which impose substantial elongation deformation. The relationship between high modulus and high draw ratio (or extrusion ratio) has been clearly established by our work [7, 9, 11, 12, 16, 17].

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The temperature pulse method for the determination of the activation energy for creep

The purpose of this letter is to draw attention to a property of a linear viscoelastic solid which has not been noticed previously and which *inter alia* offers the opportunity for an extremely precise determination of the activation energy governing the mechanism of deformation.

We seek the relationship between the creep rate of a specimen in an experiment at a constant temperature T_0 and the creep rate in a second experiment at the same stress in which for a period of time the temperature is switched from T_0 to T. In the second experiment with temperature jumps at $t'(T_0 \rightarrow T)$ and $t''(T \rightarrow T_0)$ the shear strain at time t, $\gamma(t)$, $(t > t'' > t')$ is given, according to the Boltzmann Superposition Principle [1], by