nique has many advantages over others in that it requires the minimum of sophistication and sample preparation and does not require a transparent material.

This method also enables a conservative estimate of the critical load to form strength reducing flaws in tempered materials. This last point should be of considerable interest for the prediction of the resistance of a particular tempering to the initiation of flaws owing to scratching, grinding, indenting or impacting with sharp objects.

Acknowledgements

The S.R.C. is thanked for financial support and the M.O.D. (P.E.) for a grant to the laboratory.

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Received 14 January
and Accepted 18 Feberuary 1977.

M. V. SWAIN,
J. T. HAGAN,
J. E. FIELD
Physics and Chemistry of Solids Section,
Cavendish Laboratory,
Madingley Road,
Cambridge, UK

Cavity formation at grain boundary–sub-boundary intersections in pure α-iron and an iron 0.14 wt % phosphorus alloy

It is well established that grain boundary cavities nucleated during creep do so at heterogeneous sites which are either "grown in" or produced during the creep deformation process. The mechanisms and processes suggested for cavity nucleation have been recently reviewed by Perry [1]. Some recent direct observations of cavity formation in α-iron [2] and copper alloys [3] have shown that particles located on grain boundaries are preferential sites for cavities.

This note is concerned with the behaviour of α-iron and an iron–0.14 wt % phosphorus alloy which contained a very low volume fraction of particles. The presence of the phosphorus resulted in enhanced low-temperature (−196° C) grain-boundary embrittlement and as a consequence, cavities formed during creep deformation could be

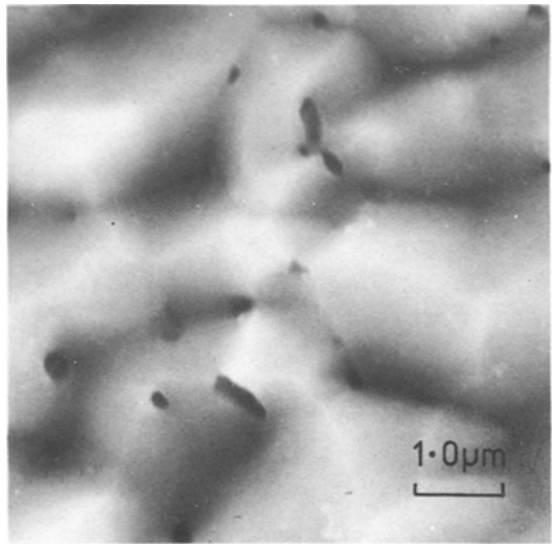

Figure 1 Sub-micron cavities and cell structure in Fe–0.14 wt % P after 21.2% creep strain at 423° C.

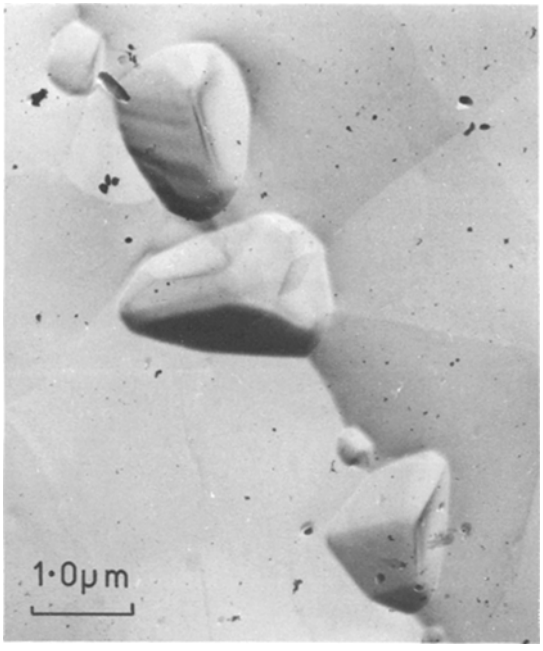

Figure 2 Carbon/platinum fractograph of cavities situated along a sub-boundary in Fe–0.14 wt % P after 11.3% creep strain at 500° C.

studied using scanning electron microscope (SEM) replica 100 kV (and 1 MV) transmission electron microscope (TEM) techniques.

In a series of experiments designed to examine cavity nucleation over a range of temperatures, 400 to 780° C, it was observed that both the iron and the iron–phosphorus alloy exhibited substantial cavitation if the test temperature was restricted to about 500° C. Fig. 1 is a SEM of an area taken from an alloy specimen intergranularly fractured under liquid nitrogen after 21.2% creep at 423° C. The grain-facet shows evidence of regions slightly misorientated to one another, and the size of these regions was found to be similar to the underlying substructure established by metallographic sectioning. The cavities observed by this technique were always associated either partly or wholly with the grain boundaries intersected by the sub-boundaries. Using the realtionship $\sigma = 2\gamma/r$, values of 169 MN m^{-2} for the tensile stress σ, and 0.8 J m^{-2} for the surface energy γ, a value of 0.01 μm was obtained for the radius r of the stable cavity. The measured values of the cavity radii were in the range 0.03 to 0.4 μm showing that the smallest cavity had only just nucleated.

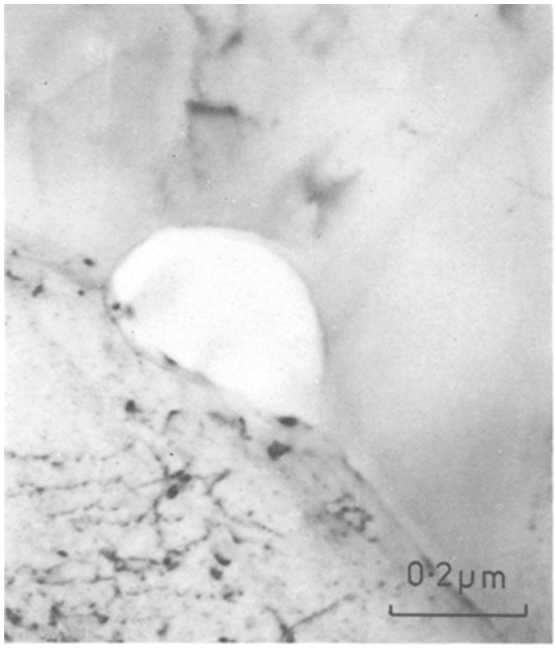

Figure 3 Cavity situated at a grain-boundary tilt in Fe–0.14 wt % P after 12.3% prestrain and 0.3% creep deformation at 500° C.

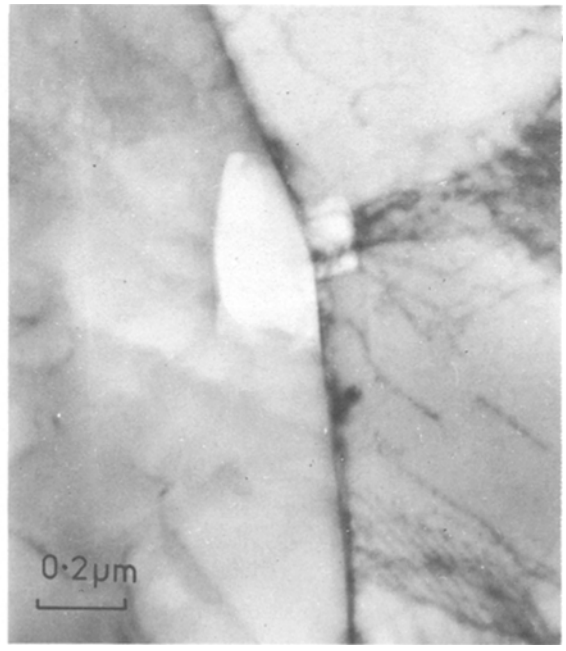

Figure 4 Cavity situated at a grain-boundary tilt in α-iron after 13.3% prestrain and 0.8% creep deformation at 500° C.

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.

Acknowledgements

The authors wish to thank the National Physical Laboratory for financially supporting this work and in particular Dr B. Dyson for his useful suggestions.

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Received 15 February
and accepted 24 February 1977

B. R. KIRBY,
C. J. BEEVERS,
Department of Physical Metallurgy and Science of Materials,
University of Birmingham,
Birmingham, UK.

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