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Fracture surface of siliconated pyrolytic graphite

Optical microscopic observations of a cross-section of pyrolytic graphite (PG) prepared at deposition temperatures (T_{dep}) of 1440 to 2025°C revealed three typical structures; fine regenerative (F; at high temperatures), string (S) and coarse (C; at low temperatures) structures which depend on preparation conditions [1]. In the case of siliconated pyrolytic graphite [PG(Si)] prepared by pyrolysis of a mixture of propane gas and silicon tetrachloride vapour, it was found that PG(Si) obtained at $T_{\mathrm{dep}} =$ 1730°C had still the fine regenerative structure while in PG(Si) at $T_{\mathrm{dep}} = 1440$°C the primary cone boundaries lacked clearness the and secondary cone boundaries were barely detectable [2]. From the results of optical microscopic observations, it seems that PG(Si) at $T_{\mathrm{dep}} =$ 1440°C and PG at $T_{\mathrm{dep}} = 1440$ and 1730°C are glass-like structures.

On the other hand, X-ray studies showed that PG and PG(Si) except for PG at $T_{\mathrm{dep}} = 1730$°C had relatively well developed crystalline structures [3]. The crystallinity of PG and PG(Si) is shown in Table I in which the interlayer spacing ($c_0/2$) [3], preferred orientation parameter (β) [3, 4] and density (d) [1, 2] are included.

It is generally assumed that the microscopic structures have a large influence on the properties of PG. However, there seems to be no detailed information on the effect of microscopic and X-ray structures on mechanical properties

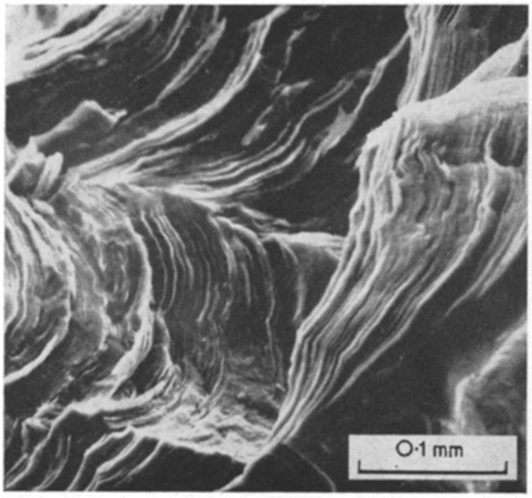

Figure 1 Fracture surface of PG prepared at 1440°C.

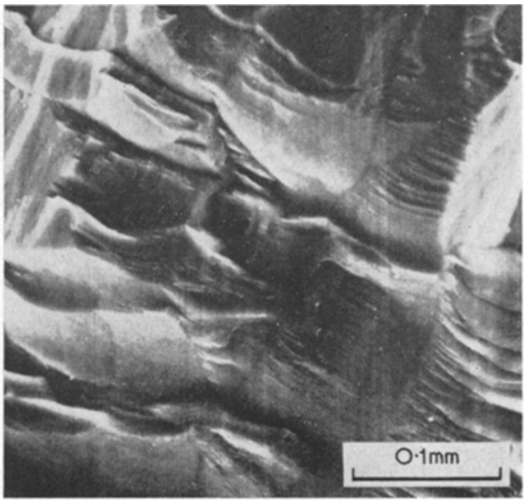

Figure 2 Fracture surface of PG prepared at 1730°C.

TABLE I Crystallinity of PG and PG(Si).

	Samples	Deposition temperature (T_{dep})°C		
		1440	1730	2025
Micro-structure	PG	S	S	F
	PG(Si)	C + S	F	F
c_0 (Å)	PG	6.87	~ 7.0	6.80
	PG(Si)	6.90	6.87	6.77
β (deg)	PG	25	40	23
	PG(Si)	23	28	23
L_a (Å)	PG	60	60	800
	PG(Si)	100	300	> 1000
d (g cm^{-3})	PG	1.9	1.2	2.2
	PG(Si)	1.9	2.2	2.2

Total gas pressure: 50 torr
Partial pressure of silicon tetrachloride vapour: 13 torr
Silicon content of PG(Si): ~ 4 wt % (1440°C), ~ 0.2 wt % (1730°C).

of PG(Si) and those of PG prepared at low temperatures, i.e. below about $T_{\mathrm{dep}} = 1800°\mathrm{C}$. The purpose of this experiment is to obtain information on the relation between the fracture behaviour and the structures. The fracture surfaces of PG and PG(Si) were examined on a scanning electron microscope (JSM-U3).

The fracture surfaces of PG are shown in Figs. 1-3. A typical laminar fracture structure is observed for $T_{\mathrm{dep}} = 2025°\mathrm{C}$ (Fig. 3), less clearly for $T_{\mathrm{dep}} = 1440°\mathrm{C}$. For this latter temperature the laminar structure has a wave-like appearance as shown in Fig. 1. In the case of $T_{\mathrm{dep}} = 1730°\mathrm{C}$ (Fig. 2), however, the fracture surface is that of a glass-like material, which is similar to that observed in glass-like carbons. These results can be related to the data shown in Table I, especially to β.

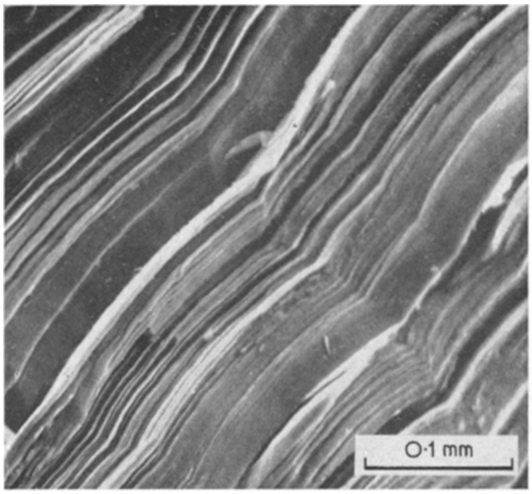

Figure 3 Fracture surface of PG prepared at 2025°C.

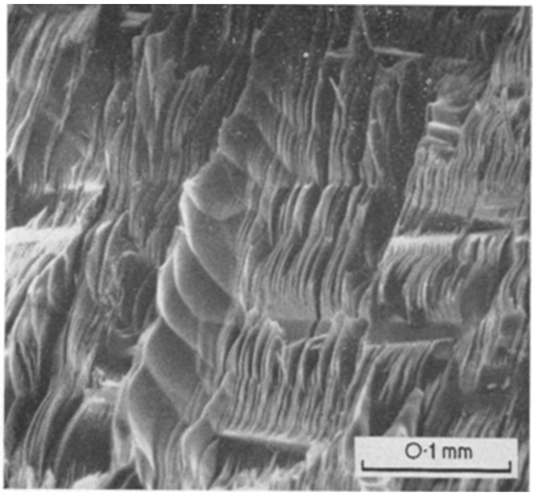

Figure 4 Fracture surface of PG(Si) prepared at 1440°C.

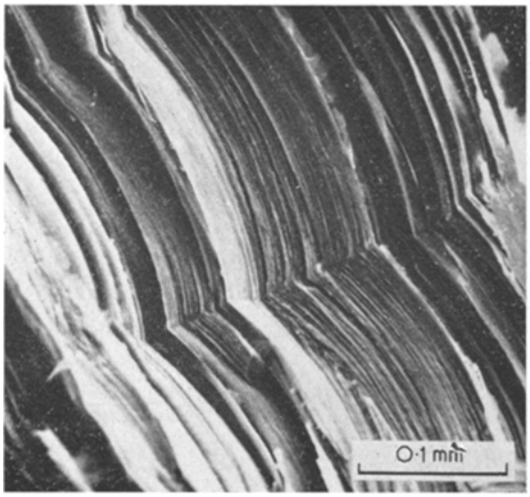

Figure 5 Fracture surface of PG(Si) prepared at 1730°C.

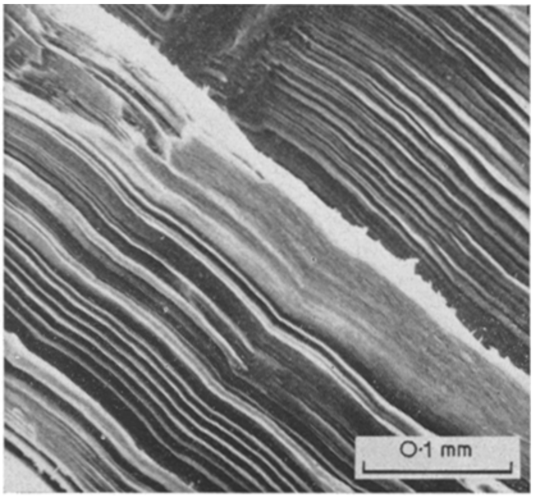

Figure 6 Fracture surface of PG(Si) prepared at 2025°C.

In the case of PG(Si), as shown in Figs. 4-6, the laminar fracture structure is clearly observed even in a sample for $T_{\text{dep}} = 1730°\text{C}$ (Fig. 5). For $T_{\text{dep}} = 1440°\text{C}$ (Fig. 4), a small amount of a glass-like structure may be included.

The present experimental results imply that the fracture behaviour is closely related to the X-ray structures but not to the microscopic structures. Especially for PG(Si), the presence of SiC seems to affect the fracture behaviour.

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Short notices

Principles of Metal Surface Treatment and Protection

D. R. Gabe
Pergamon Press. 180 pp. £3·00

This book sets out to provide an introduction to the principles of metal surface treatment and protection at a level suitable for both the professional metal finisher and a student of metal finishing. It covers a wide field with chapters on the Scope of Protection, Electrodeposition, Hot Dip Coating, Diffusion Coatings, Non-metallic Coatings, Oxide and Conversion Coatings, Testing and Selection, and the Theory of Corrosion Protection. The coverage of any one topic is of necessity rather brief but this should cause no concern to a reader with some prior knowledge of the field and the book could be of value both as a revision of basic principles and as an up-to-date review of the state of the art. To a student with little or no background knowledge it could, however, be hard going especially in the earlier chapters where new ideas are presented at a rate which makes them difficult to assimilate. Nevertheless on balance it is a useful book which this reviewer is happy to recommend.

D.A.W.

Fibres, Films, Plastics and Rubbers

A Handbook of Common Polymers by
W. J. Roff and J. R. Scott
Butterworths. 688 pp. £15·00

This volume is a completely revised, updated and extended version of an earlier work of reference, "Fibres, Plastics and Rubbers" by W. J. Roff. Its intended readership ranges from the student to the specialist and it contains such a wealth of information that this reviewer is satisfied that it will succeed admirably. Such a handbook stands or falls on the ease with which its subject matter can be retrieved: The firm and logical structure of this work ensures that it fulfills this requisite.

The book is divided into two parts. The first contains data on individual polymers which are grouped together on the basis of their structure and chemical properties, while the second part deals with specific properties and other related information concerning polymers in general. Thus in Part I olefin and vinyl-type polymers are considered in sections 1-12, carbohydrates in 13-19, proteins in 20-22, synthetic condensation-type polymers in 23-28, natural and synthetic rubbers in 29-40, organosilicones in 41 and inorganic polymers in 42. Within each section synonyms and trade names of the polymer are