

barrier itself. When each deflection is corrected so that zero deflection occurs at zero length of the film, the remaining deflection reflects the shear force on the film, and perhaps such secondary effects as the changing angle of contact of the surface, and the changing column of water supported by the barrier and the connecting surfaces. Each deflection curve was adjusted to give zero deflection at zero length (Fig. 4). The deflection (thus the force) is a linear function of velocity and of length.

Since the viscosity of the water was not varied, we cannot define the dependence of force on viscosity, but we suspect that the force is a linear function of Reynolds number VL/ν . Full interpretation of the barrier deflection may require knowledge of the wetting angle and the height of liquid supported by the barrier.

It is well known that for parallel flow along a rigid flat plate with a sharp leading edge the total force is proportional to the three-halves power of velocity and to the one-half power of length. If the plate itself is fluid (as is the film layer), measurements indicate that the force is linear with velocity and that the shear stress is constant along the film.

Thus our observations indicate that the barrier collected surface-active material from upstream; the film was subjected to the drag of the water flowing under it and was restrained by the barrier.

The expanded phase made up approximately half the length of a fully developed film (Fig. 1). The lack of evidence of discontinuity of surface tension along the films (Fig. 3) indicates that perhaps the drag on the expanded and condensed phases is the same.

When an axial force (usually called surface pressure) is applied to a monolayer, it is counterbalanced by a decrease in surface tension (5). In our studies, a shear force was applied to the film, but our findings indicate that the shear stress is proportional to the first power of velocity, whereas the surface-tension gradient is proportional to the second power—that is, the surface-tension gradient will not generally balance the shear stress. Evidence of the effect of this imbalance of forces on a particle of the surface film is the cellular circulation pattern observed.

The irregularity of the decrease in

surface tension near the leading edge probably reflects the curvature of the film at the ripple. The film surface appeared to be elevated slightly at the leading edge, requiring extra forces to support its elevated mass.

As an idealization, let us suppose that the linear relation between the decrease in surface tension and the square of the velocity was also true for the leading portion of the surface layer: $\sigma_0 - \sigma = KV^2x$. Since the drop in surface tension between the leading edge and the barrier is always the same, it follows that the equilibrium length is inversely proportional to the square of the velocity, and this is approximately true (Fig. 2).

The classical treatment of a fluid sphere moving in a fluid medium assumes no special interfacial effects, considering only the respective viscosities of sphere and medium. But gas bubbles often move as if they are encapsulated in a rigid shell. It is usually assumed that a film of surfactant collects at the interface and that the flow around the sphere (2), with its resultant shear stress, compresses the surfactant and pushes it to the rear of the sphere. Since surface tension is strongly altered by small concentrations of surfactant, it is assumed that the shear stress creates surface-tension gradients from the front to the rear of the sphere. The nature of these gradients and the relation between them and the shear stress are not understood, however.

We report, for a simple two-dimensional flow, observations of surface-tension gradients created by the flow, the magnitudes of the gradients, and the dependence of the gradients on velocity and distance from the leading edge; the total forces on films of various lengths were also noted. Without measuring surface-tension gradients in growing films, however, one cannot relate interfacial shear stresses with corresponding surface-tension gradients. We did not study the effect of variations in substrate viscosity or density, or the effect of film chemistry.

LYLE F. MOCKROS

Technological Institute, Northwestern University, Evanston, Illinois 60201

RAY B. KRONE

College of Engineering, University of California, Davis 95616

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4. Symbols: D , displacement of pendulum barrier; D_i , end-effect correction for displacement; K , proportionality constant; L , length of surface film not in equilibrium; L_s , steady-state length of surface film; N_w , Weber number; V , velocity of surface of free stream; x , distance downstream from leading edge of surface film; ν , kinematic viscosity of water; σ , surface tension within surface film; σ_0 , surface tension of free stream; σ_i , end-effect correction on surface tension.
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A New Allotropic Form of Carbon from the Ries Crater

Abstract. *A new allotropic form of carbon occurs in shock-fused graphite gneisses in the Ries Crater, Bavaria. The assemblage in which it occurs consists of hexagonal graphite, rutile, pseudobrookite, magnetite, nickeliferous pyrrhotite, and baddeleyite. Electron-probe analyses indicate that the new phase is pure carbon. It is opaque and much more strongly reflecting than hexagonal graphite. Measurement of x-ray diffraction powder patterns leads to cell dimensions $a = 8.948 \pm 0.009$, $c = 14.078 \pm 0.017$ angstroms, with a primitive hexagonal lattice.*

The material was recognized as a possible new mineral because of its distinctive optical properties in polished sections of shock-fused graphite gneisses from the Ries Crater in Germany. The mineral is slightly harder than graphite, and its reflection color is metallic gray to white. It occurs as relatively thin lamellae (3 to 15 μm wide) alternating with graphite and perpendicular to the 0001 face of graphite (Fig. 1). No an-

isotropism was observed, probably on account of the extremely small grain size.

Detailed optical studies in reflected light of numerous shocked graphite gneiss specimens from different localities in the Ries Crater revealed that only a small fraction of the graphites contain the new form of carbon. The new mineral, which very probably has been formed from hexagonal graphite by

shock, was observed only in specimens where the silicates were fused to glass. This fused glass also contains several graphite grains without lamellae of the new phase.

In an attempt to recover the new mineral in pure form for detailed studies, several kilograms of shocked

graphite gneisses from the locality of Möttingen in the Ries Crater were dissolved in hydrofluoric acid. The undissolved residue consisted of a mixture of graphite, zircon, and rutile. The polished sections prepared from the graphite, zircon, and rutile residue contained only a very small fraction of

the new form, also occurring as lamellae in hexagonal graphite.

A graphite grain with more than 35 percent of the new phase was measured with an electron-microprobe analyzer (Materials Analysis Co., Model 400). Qualitative determinations were performed under a stationary beam and by running the spectrometers from boron through uranium. Except for small amounts of Si and Cl (less than 0.5 percent), carbon was the only major element detected. The Si and Cl traces appear to be due to contamination by the glass matrix and by the araldite mounting material in which the sample is embedded. Several electron-probe profiles through neighboring grains of graphite and the new phase indicated no measurable change in the carbon counts.

A graphite grain containing more than 60 percent of the new phase, as estimated under the reflecting microscope, was carefully isolated mechanically from the polished section and mounted without crushing in a Debye-Scherrer camera (114.6-mm radius); $\text{CuK}\alpha$ and $\text{FeK}\alpha$ radiations were used ($\lambda_{\text{Cu}} = 1.5418 \text{ \AA}$, $\lambda_{\text{Fe}} = 1.9373 \text{ \AA}$). The powder patterns consisted of 22 sharp lines (Table 1), in addition to the strongest 11 lines of hexagonal graphite. There was no evidence of preferred orientation. No rhombohedral graphite lines were observed.

A primitive hexagonal cell with dimensions $a = 8.948 \pm 0.009$, $c = 14.078 \pm 0.017 \text{ \AA}$, obtained with Burnham's LCLSQ (lattice constant least squares) program (1), permits the indexing of all observed lines (Table 1). No 0001 reflections are observed, so that a layer structure can be ruled out. The nature of the principal axis of symmetry is, however, undetermined. If a holohedral space group $P6/mmm$, which has a 24-fold general position, is assumed, a reasonable calculated density of 3.43 g/cm^3 can be obtained by filling the general position seven times, giving 168 atoms per cell. Not enough of the pure, new form of carbon has yet been isolated for density measurements.

A. EL GORESY
G. DONNAY

*Geophysical Laboratory,
Carnegie Institution of Washington,
Washington, D.C. 20008*

Reference

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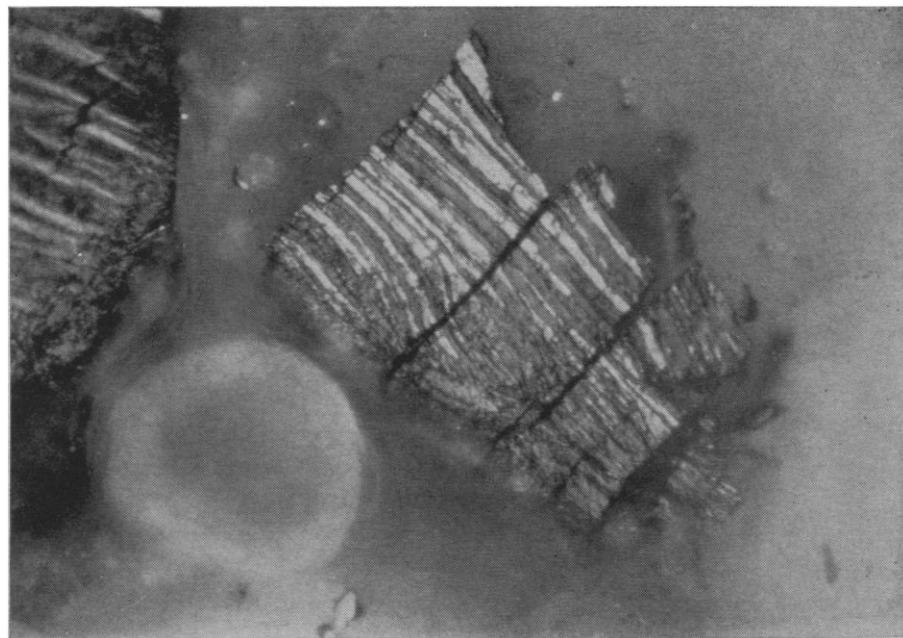


Fig. 1. The new form of carbon (white, strongly reflecting lamellae) closely intergrown with hexagonal graphite (gray) in the glassy groundmass. Reflected polarized light, oil immersion, magnification $\times 800$, Möttingen, Bavaria.

Table 1. X-ray powder pattern of new form of carbon. Copper radiation; nickel filtered. Abbreviations: v.v.st., very very strong; v.st., very strong; st., strong; m, medium; w, weak.

Number	Observed	Calculated	Intensity	hkl
1	4.47	4.465	v.v.st.	11•0
2	4.26	4.256	v.v.st.	11•1
3	4.12	4.014	v. st.	10•3*
4	3.71	3.728	m	20•1
5	3.22	3.206	m	10•4
6	3.03	2.985	st.	20•3
7	2.94	2.923	w	21•0
8	2.55	2.536	st.	30•1
9	2.46	2.482	m	21•3
10	2.28	2.277	st.	20•5
11	2.24	2.232	m	22•0
12	2.10	2.080	m	30•4
13	1.983	2.007	w	20•6
14	1.910	1.915	w	40•1
15	1.496	1.495	w	22•7
16	1.370	1.370	w	41•6,22•8
17	1.289	1.289	w	60•0,50•6
18	1.26	1.257	w	33•6
19	1.197	1.197	m	33•7,52•3
20	1.184	1.183	m	42•7
21	1.080	1.0815	w	41•10
22	0.8642	1.8643	w	41•14

*Possibly the strongest line of an impurity, since the disagreement of observed and calculated interplanar spacing, 2.7 percent, is considerably greater than that for the next poorest reflection, 20•3, where it is 1.5 percent.