deficit) close to the sea surface should be similar. Second, the mean residence time of an SO_2 molecule in the atmosphere should be of the same order as that for a water molecule ($\sim$10 days, ref. 11). This contrasts with the much larger residence time for a CO_2 molecule ($\sim$7 yr, ref. 12); in this case, exchange is controlled by resistance in the liquid phase. A residence time of about 10 days for SO_2 is in reasonable agreement with the mean value of 5 days given by Junge[11].

I thank Mr A. C. Chamberlain of AERE, Harwell, for helpful discussions and comments on the manuscript.

P. S. Liss

School of Environmental Sciences,
University of East Anglia,
Norwich, NOR 88C

Received June 17; revised August 23, 1971.

1 Danckwerts, P. V., *Gas–Liquid Reactions*, 145 (McGraw-Hill, London, 1970).
2 Bolin, B., *Tellus*, **12**, 274 (1960).
3 Skirrow, G., in *Chemical Oceanography* (edit. by Riley, J. P., and Skirrow, G.), **1**, 227 (Academic Press, London, 1965).
4 Hoover, T. E., and Berkshire, D. C., *J. Geophys. Res.*, **74**, 456 (1969).
5 Schooley, A. H., *J. Mar. Res.*, **27**, 335 (1969).
6 Downing, A. L., in *River Pollution* (edit. by Klein, L.), **2**, 224 (Butterworths, London, 1962).
7 Terraglio, F. P., and Manganelli, R. M., *J. Air Pollut. Control Assoc.*, **17**, 403 (1967).
8 Eigen, M., Kustin, K., and Maass, G., *Z. Phys. Chem.*, **30**, 130 (1961).
9 Adams, F. W., *Ind. Eng. Chem.*, **25**, 424 (1933).
10 Whitney, R. P., and Vivian, J. E., *Chem. Eng. Prog.*, **45**, 323 (1949).
11 Junge, C. E., *Air Chemistry and Radioactivity*, 3 (Academic Press, London, 1963).
12 Craig, H., *Tellus*, **9**, 1 (1957).

Determination of the Density of Seawater

KREMLING has recently described[1] a promising new method for the determination of the density of seawater. The agreement he demonstrates between his results and those based on the equation of state, determined by Knudsen as a function of salinity and temperature, is even better than he suggests. This arises from an error in Kremling's interpretation of the new definition of salinity.

Salinity, S, is now defined by the International Tables[2] in terms of conductivity. The best estimate of chlorinity[3] is obtained by using the relation $Cl = S/1.80655$ and not the Knudsen equation. One thus arrives at a lower value for Cl than estimated by Kremling which is most marked for the lower values of Cl. When the densities are recalculated one finds that Kremling's estimates are reduced by 0.20 at $S = 5\%$ and by 0.009 at $S = 20\%$ with linear interpolation between. Application of this correction suggests complete agreement in the mean with Knudsen and exemplifies once again the great quality of standards measurements in the early years of the century.

J. Crease

National Institute of Oceanography,
Wormley,
Godalming,
Surrey

Received August 9, 1971.

1 Kremling, K., *Nature*, **229**, 109 (1971).
2 *International Oceanographic Tables* (National Institute of Oceanography of Great Britain and UNESCO, 1966).
3 Cox, R. A., Culkin, F., and Riley, J. P., *Deep-Sea Res.*, **14**, 203 (1967).

Structure of Fibrous Carbon

THE existence of fibrous or whisker carbon has been reported in both synthetic studies of graphite[1,2] and in naturally occurring graphite[3]. The synthetic studies involved decomposition of hydrocarbons over metals[1] and decomposition of carbon monoxide over iron[2] and, particularly in the second of these studies, the occurrence of metal catalyst within the fibre was observed. Furthermore, it has been established[1] that the average orientation of the carbon crystallites is with their (0002) orientation parallel to the axis of the fibre. In this communication we describe the use of high resolution electron microscopy to establish the precise relationship between the orientation of the graphite planes and the catalyst particle within the fibre.

A nickel foil was heated to 700° C in 600 mm Hg of methane or propane for several hours and the ensuing film of graphite was stripped from the foil surface by immersion in concentrated HCl. The film of graphite was sufficiently thin to be studied by transmission electron microscopy and it contained outcrops of fibrous carbon as well as polycrystalline and high quality graphitic carbon. Fig. 1*A* shows the appearance of a typical carbon fibre formed in an atmosphere of methane, the very high width to length ratio of the fibres formed in methane being characteristic of this hydrocarbon. Fig. 1*B* is an enlargement of part of the previous figure so that the (0002) lattice planes can be seen. There are three principal regions of the fibre: in the centre is an irregular particle of what is believed to be metal (in this case it would be nickel) and surrounding this is a highly crystalline carbon with the (0002) lattice planes parallel to the surface of the metal particle; on the periphery of the fibre there is a narrow region of amorphous carbon. The first point of interest is the close parallelism of the graphite layer planes with the surface of the metal particle, because it has been reported

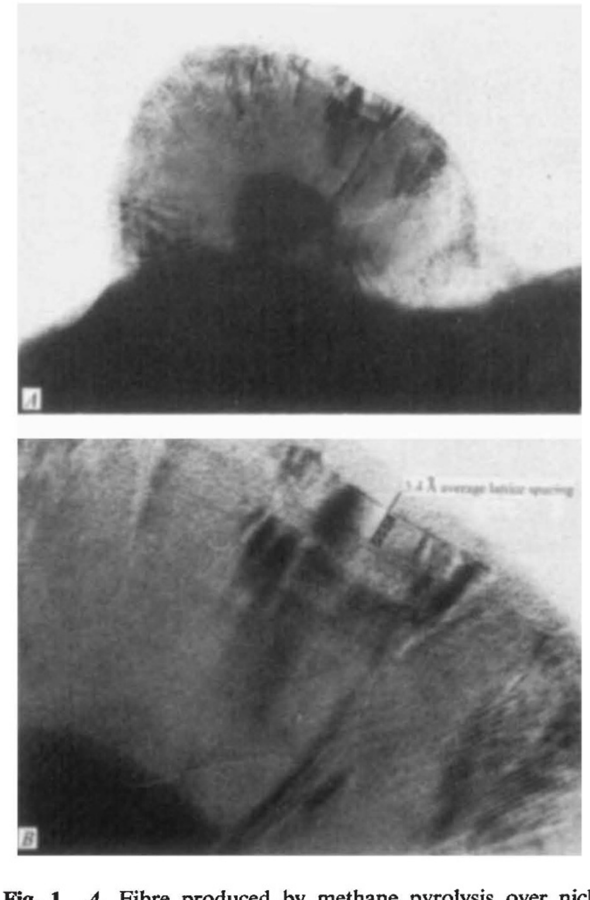

Fig. 1 *A*, Fibre produced by methane pyrolysis over nickel (×312,000); *B*, Enlargement of a region of Fig. 1*A*, with (0002) lattice planes delineated for identification (×1,000,000).