

short lived species the importance of which has recently been demonstrated³, and we have examined its effect on aqueous ammonia and how it could be produced in seawater.

Singlet oxygen was produced by dye photosensitization of aerated solutions of eosin, rose bengal, methylene blue or riboflavin. When a solution containing ammonia, 10^{-2} M, and a dye, 10^{-4} M, is irradiated with visible light which is absorbed by the dye in the presence of air, nitrite and nitrate are produced but none appear if the dye or ammonia is absent under the same illumination conditions. (It has been shown that in some conditions N_2 can be oxidized to NO_2^- by singlet oxygen⁸.) The nitrite ions are determined by colorimetry using Bendschneider and Robinson's method⁴ and the nitrate ions by Taras's method⁵ using phenol disulphuric acid. Experiments were also carried out in seawater to which ammonia and dyes were added. Identical results were obtained.

The nitrite and nitrate yields are small. Exposing the solutions described here, adjusted to pH 8.5, to a 300 W tungsten lamp in a Pyrex cell, gives about 10^{-5} M of both ions after 2 h of illumination. The yields increase with pH, which indicates that the oxidized species is NH_3 rather than NH_4^+ .

Dyes in aqueous solution are destroyed by light even in the absence of added solutes. The decomposition is even more rapid in the presence of buffer mixtures such as phosphates, carbonates and borates, whether in oxygenated or in unoxygenated solutions. Because oxidation of leuco dyes by oxygen in water gives peroxides⁶, we have checked that this process is not responsible for the oxidation of ammonia.

We also prepared singlet oxygen by another procedure, using an apparatus designed by Douzou and Balny⁷. Hydrogen peroxide and sodium hypochlorite are allowed to react in one compartment, producing singlet oxygen which is carried by a stream of nitrogen to another compartment 3 cm away where it is bubbled through an ammoniacal solution. Nitrite and nitrate are produced, but again in small quantities, and the yields also increase with the pH of the solution. We therefore conclude that singlet oxygen, $^1\Delta$, is able to oxidize ammonia in aqueous solution.

Numerous aromatic compounds in seawater can photosensitize the production of singlet oxygen. Among the substances which absorb in the visible range, riboflavin seems to be the most promising species, although its concentration is very small. With substances which absorb in the near ultraviolet, the photosensitive process competes with direct photo-oxidation of ammonia⁹. We have found that this latter process becomes very important with light of wavelength below 320 nm.

It would be interesting to estimate the amount of nitrification in seawater from the photosensitized mechanism, and to extend this finding to other media, such as waste water containing ammonia and organic compounds.

We thank Professor Creach and Dr Uliana for suggestions and for helpful discussion, and Drs Douzou and Balny for allowing us to use their apparatus.

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Received March 16, 1970.

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New High Temperature Carbon Fibre Composite

We have prepared in this laboratory carbon composites reinforced with carbon fibres which have flexural strengths of 120,000 to 140,000 pounds per square inch at room temperature and 125,000 to 150,000 pounds per square inch at 1,500° C (in helium). The composites are reinforced unidirectionally with carbon fibres which make up 75-80 per cent of the total by weight. Densities range from 1.4 to 1.64 g/ml.

The composites are prepared by impregnating Morganite I carbon fibre bundles with one of several possible resins in solution, evaporating off the solvent in vacuum and curing the sample in a mould under heat and pressure. The resulting carbon fibre reinforced polymer composite is then heated in vacuum at high temperature (700°-1,000° C) to carbonize and volatilize the polymer. This treatment is followed by the deposition of pyrolytic carbon within the resulting porous structure using a hydrocarbon gas at high temperature in carefully controlled conditions. By this technique it is possible to replace all or more of the weight lost on pyrolysis with pyrolytic carbon. This can be done in a few hours for small samples made from polymers giving a high char yield, but better results are obtained by extending the deposition of carbon to longer periods.

The flexural strengths were obtained on samples 1.5 inches long, 85 mils wide and 53 mils thick with a span of 1.2 inches and a loading nose with a radius of 3/8 inch moving at 0.05 inch/min. The stress-strain curves were straight and their slope yielded an elastic modulus of 20-30 million pounds per square inch for the composites. All of the failures were caused by crushing on the compression side. Interlaminar shears run on the same sized samples with a span of 0.3 inch and a loading nose radius of 1.16 inch gave values from 2,000-4,500 pounds per square inch at room temperature.

The impact strength of these composites is comparable with the impact strength for epoxy matrix composites made with the same carbon fibre. This high strength, however, must be set against the poor resistance to oxidation of these composites at high temperatures.

Ageing at 500° C in air for eight hours reduced the interlaminar shear strength to less than 50 per cent of the original value. Methods of protecting the composites from oxidation and improving interlaminar shear are now being investigated.

Fuller details of this procedure will be made available after patent applications now pending have been granted.

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Received May 25, 1970.

Polyethylene Spherulites

THERE has been some controversy about the report that polyethylene does not produce spherulites resolvable with a light microscope¹⁻³ but instead produces a complex birefringent mass made up of units less than 1 μ m in diameter (see Figs. 1 and 2 of ref. 1). Previous reports that polyethylene readily produces spherulites, 0.1 to 1.0 μ m in diameter^{4,5}, have been attributed to the use of excessive pre-heat treatment above 250° which degrades the polymer, produces excessive thinning of the sample films and destroys nuclei. Organ (private communication), however, considers that the lack of resolution is entirely due to