matters arising

Phase transitions and indentation hardness of Ge and diamond

SINCE publication of our letter[1] on phase transitions and indentation hardness of Ge, Si and diamond our attention has been drawn to the paper by Gridneva *et al.*[2] on the hardness of diamond-like solids. They directly confirm the formation of a metallic phase below the indenter due to the high hydrostatic pressure generated in the contact zone. Ruoff[3] has expressed some doubts as to the occurrence of a metallic transition in the experiments of Vereshchagin *et al.*[4]. However, in discussion of a more recent paper he notes that with small spherical indenters indentation pressures as high as 19,000 kg mm^{-2} might be reached[5]; this exceeds the value of 17,000 kg mm^{-2} estimated by van Vechten[6] as the pressure required to produce the metallic phase in diamond. The concept of a metallic phase below the indenter is also implied by Gilman[7] who proposes that the resistance to flow is determined by the need for two bonding electrons to be promoted into the conduction band. This he relates to the band gap. We have used the bond gap[8] rather than the band gap as this provides a better measure of the average energy to break the covalent bond.

D. TABOR

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Oxygen production from chlorophyll-liposomes

THE report of Toyoshima *et al.*[1] on the evolution of oxygen with chlorophyll-containing liposomes is of considerable interest. We have been unsuccessful in our attempts at doing essentially the same experiments[2]. In contrast, we readily measured oxygen uptake by chlorophyll-liposomes as the pigments became irreversibly photooxidised[3]. In addition to ferricyanide (the Hill acceptor used by Toyoshima), we used several other electron acceptors and could always measure oxygen consumption (Fig. 1), and as well as the basic experiment reported by Toyoshima, we tested many buffers, salts, *p*H's, temperatures, electron donors and acceptors and membrane components, and always observed uptake.

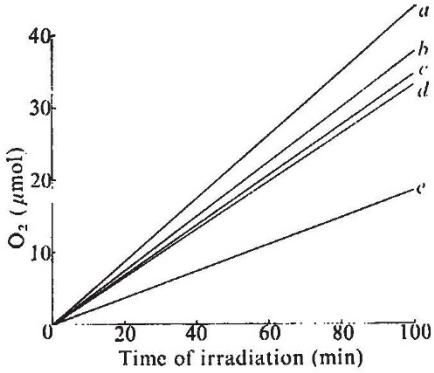

Fig. 1 The effect of electron acceptors on oxygen consumption with chlorophyll-liposomes. *a*, 1 mM dehydroascorbate; *b*, 1 mM methyl viologen; *c*, no addition (control); *d*, 1 mM ferricyanide; *e*, 1 mM benzoquinone.

Toyoshima *et al.* prepared their liposomes in 0.1 M potassium ferricyanide, 0.5 M Tris and 0.1 M KCl at *p*H 7.5, and separated the unsequestered ferricyanide from the ferricyanide-encapsulated liposomes on a Sephadex G-50 column presaturated with the washing buffer, 0.5 M Tris and 0.1 M KCl at *p*H 7.5. The problem is that the ionic strength of the internal ferricyanide is not compensated for in the washing buffer. It is hard to imagine the ferricyanide-encapsulated liposomes not swelling and breaking, and releasing the trapped ferricyanide on passage down the column. Additionally, 0.5 M Tris is a poor buffer for relevant oxygen evolution studies as large quantities of Tris are known to destroy oxygen evolution *in vivo*[4].

Our main criticism centres around Toyoshima's total lack of temperature controls. We were not able to measure any oxygen evolution with the stringent temperature controls (usually 25 ± 0.1 °C) used in our experiments. However, we did carry out experiments in which we allowed the temperature of the chlorophyll-liposomes to rise in the dark. In these conditions, we were able to measure apparent 'oxygen' at levels similar to those reported in Fig. 2 of Toyoshima, with temperature increases of between 0.5 and about 4 °C. As Toyoshima employed a 500-W xenon lamp, the possibility of heating artefacts remains quite real.

We believe the experiments reported by Toyoshima *et al.* should be repeated using stringent temperature controls and different buffers, and also checking the effect of classic oxygen inhibitors like DCMU and hydroxylamine, and oxygen stimulators like Mn^{2+} and bicarbonate[5].

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Energy flow and the number of trophic levels in ecological communities

PIMM and Lawton[1] showed, using Monte Carlo simulation methods, that the return times to equilibrium, T_R, following small perturbations to ecological food chain populations modelled by Lotka–Volterra equations, are positively correlated with the lengths, L, of the food chains. We have made similar studies[2] showing T_R to be strongly positively correlated with $T_M(1-n)$, the mean transit time of a molecule or unit of energy from the bottom (autotroph) to the top (top carnivore) of the food chain; T_R is positively correlated with L only if $T_M(1-n)$ is positively correlated with L, which need not always be the case.

Our point can be made analytically for the simple food chain of n species,

$$\frac{dX_i}{dt} = X_i(b_i + \sum_{j=1}^{n} a_{ij}X_j) \quad (i = 1,2,\ldots,n)$$

where we assume $b_1 > 0$, $b_i = 0$ $(i > 1)$, since only the bottom species is autotrophic. It can be shown[2] that the equilibrium densities, X_i^*, are proportional to b_1, and that the eigenvalues of the equations linearised about the equilibrium values are also proportional to b_1. The return time, T_R, of the perturbed system is roughly proportional to $-1/\mathrm{Real}(\lambda_{max})$, where $\mathrm{Real}(\lambda_{max})$ is the largest real part of any of the eigenvalues of the system. The transit times of a molecule up the chain from one species

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