MATTERS ARISING

Ordering of FeNi in clear taenite from meteorites

CLEAR taenite in meteorites[1] contains 48–57% Ni and is optically anisotropic[2], unlike taenite (γ Fe,Ni) which is isotropic. We have proposed[2] that clear taenite is composed of ordered FeNi, a phase first identified in iron meteorites by Albertsen *et al.*[3]. Mehta *et al.*[4] have obtained additional evidence for ordering in clear taenite from their electron-optical studies of a large grain, which one of us (R.S.C.) discovered in the Estherville meteorite. However, they interpret their data to indicate that clear taenite is composed of regions of ordered FeNi, which are 1–3 μm in diameter, in a matrix of disordered γ (taenite) of similar composition. We argue here that this conclusion is in all probability incorrect.

On ordering of FeNi, cubic taenite inverts to the tetragonal CuAu or $L1_0$ structure. Because of this symmetry change, three sets of intergrown crystallites of ordered FeNi, which are oriented in mutually perpendicular directions, form from a single crystal of taenite. These crystallites, which can be observed in reflected light under crossed polars[2], are typically 1–10 μm in diameter.

Mehta *et al.*[4] observed extra superlattice diffraction spots from the $L1_0$ structure in preferentially thinned regions of clear taenite in which the [110] direction was parallel to the electron beam. The thicker regions which did not show extra diffraction spots were interpreted by Mehta *et al.* to be disordered γ. We suggest instead that the thicker regions actually contained sets of ordered crystallites with [101] and [011] directions parallel to the beam. On the original taenite axes, the unit cell of ordered FeNi is C-centered and has dimensions which are very close to those of taenite[3]. Ordered crystallites with [101] and [011] parallel to the beam would therefore show diffraction patterns that are indistinguishable from those of disordered γ. Thus we are confident that Mehta *et al.* misidentified ordered FeNi crystallites as disordered taenite. If we are correct, all regions of {100} sections of clear taenite will show extra superlattice spots, as in this orientation all three sets of crystallites show superlattice diffraction spots.

Although they acknowledge that our interpretation is consistent with their data, Mehta *et al.*[4] strongly emphasize their own conclusion that clear taenite contains ordered FeNi regions in a disordered γ matrix. Other contrary evidence is provided by Mössbauer[3,5] and optical[2] studies of meteoritic metal, which have failed to detect disordered γ of the size, composition and abundance that Mehta *et al.* propose. We still conclude[2,6] that clear taenite is a new mineral, ordered FeNi.

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Differences in fluidity between bilayer halves of plasma cell membranes

ASYMMETRY in the composition of membrane bilayer halves raises the possibility that the individual monolayers have independent physical properties. Recently, Shroeder[1] proposed a method for analysing the fluidity of the individual monolayers of tumour cell plasma membranes. He used an impermeable reagent, trinitrobenzenesulphonic acid (TNBS), covalently linked to outer monolayer amino groups, to quench the fluorescence of *trans*-parinaric acid, a probe which distributes in both monolayers. He contends that the fluorescence of the outer monolayer was quenched and that the elevated polarization of the residual fluorescence reflected a lowered mobility of the *trans*-parinaric acid located in the inner monolayer.

We suggest that TNBS linked to outer monolayer phospholipid amino groups quenches the fluorescence of *trans*-parinaric acid in the two monolayers to a different extent. Because any energy transfer process reduces the donor probe fluorescence lifetime[2], the observed elevation of the polarization of the unquenched *trans*-parinaric acid fluorescence may reflect the impact of the transfer process on fluorescence lifetime[3] rather than probe mobility. Our arguments are based on the following considerations.

(1) The width of membrane lipid bilayers (between opposite polar headgroups) is generally agreed to be less than 50 Å (ref. 4). (2) *trans*-Parinaric acid, 9, 11, 13, 15, all *trans*-octadecatetraeonoic acid is an extended molecule, orientated with its carboxyl group near the polar headgroup. We expect the relatively inflexible tail of *trans*-parinaric acid to be near the middle of the bilayer with the midpoint of its transition dipole (between C-12 and C-13) ~6 Å to either side of the centre of the bilayer. (3) R_0, the distance at which energy transfer between parinaric acid and covalently linked TNBS is 50%, is calculated by standard procedures[5], applicable to membrane bilayer energy transfer to be 23 Å. (4) For a bilayer 48 Å wide, *trans*-parinaric acid chromophores in the outer and inner monolayers will be ~18 Å (0.78 R_0) and 30 Å (1.3 R_0), respectively, from the trinitrophenyl chromophores. (5) With the geometry specified above, we calculate by the method of Wolber and Hudson[6] that, to achieve the 44% reduction of fluorescence of *trans*-parinaric acid by energy transfer between *trans*-parinaric acid and TNBS reported by Schroeder, a TNBS surface density of 0.6 TNBS/R_0^2 is required. The calculations show that ~60% of the outer monolayer and ~27% of the inner monolayer fluorescence are transferred. (6) Fluorescence lifetimes are reduced by energy transfer to an extent similar to the detected change in fluorescence quantum yield[2,5]. For isotropically rotating probes, the Weber–Perrin equation[7] predicts that the lifetime changes in *trans*-parinaric acid caused by the presence of TNBS are alone sufficient to account for the observed elevation of the polarization.

As it seems that the motion of linear probes like *trans*-parinaric acid in membranes is not isotropic[8,9], the extent to which the observed steady-state polarization depends on the probe fluorescence lifetime is a function of both the rate of chromophore motion and its angular extent[3]. These parameters are probably influenced by membrane proteins and cholesterol[10] and can only be extracted by nanosecond polarization measurements[3]. We have, however, observed that the steady-state polarization of parinaric acid probes, confined to the surface monolayer of a serum lipoprotein and quenched by surface-bound energy transfer acceptors, is elevated to an extent comparable to that reported by Schroeder in tumour cell membrane bilayers (L.A.S., unpublished results).

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