Thermal Conductivity of Glycine

RECENTLY it has been suggested[1-3] that electron spin resonance studies of irradiated amino-acids reveal thermal effects as well as directly induced free radicals. The model proposed is that absorption of radiation energy may lead to a localized heating of small regions; this may allow radical reactions to take place at a rate characteristic of a much higher temperature than the average temperature of the sample. Evidence for this model includes the fact that there are differences in the spectra from irradiated glycine and valine after very high doses and lower doses of radiation energy[1]; the effects of different linear energy transfer radiations[2]; and the changes in the glycine spectra as functions of dose and time[3]. The validity of such a model depends on the assumption that the energy deposited by the radiation cannot diffuse by a conduction process, as only then can a local "hot spot" be created. A theoretical examination of this problem is hampered, however, by a lack of knowledge of the processes involved; in particular, no measurements have been made, as far as is known, on thermal conductivities. As a first step, an investigation was therefore made of the thermal conductivity of a single crystal of glycine.

The method adopted was the thermal-comparator technique (ref. 4, Fig. 7) developed by Powell. A 'Chromel' probe block was used, and a 100 g weight, which could be fixed on the top, ensured a constant pressure by the comparator on the system. The potential difference from the thermocouple was measured with a microstep potentiometer (Cambridge Instrument Co., Ltd.). Three reference materials of known conductivity (0·0037, 0·010 and 0·018 Joules cm/cm²sec °C) were used to calibrate the comparator.

The single crystals of glycine were grown by slow evaporation from aqueous solution. They are monoclinic in form, with an elongation along the *c*-axis. Surfaces parallel to the *a*–*c* plane had the largest dimensions (approximately 1 cm × 0·5 cm) and their thickness was 2–3 mm. Most of the measurements were made with the probe resting on the *a*–*c* plane surface, although a few were tried on the *b*–*c* plane surface. None were possible on the *a*–*b* plane surface as the dimensions were too small to support the probe. No significant difference was found between the two surfaces investigated.

Measurements were made with the comparator at 60° C and 82° C, the temperatures being taken with a mercury-in-glass thermometer monitoring the oven used to heat the comparator. Results are plotted in Fig. 1, where the circled points refer to the glycine. Comparator readings have standard deviations of about ±2 per cent, and to this degree of accuracy it can be seen that there is no difference in the thermal conductivity of glycine at the two temperatures used. It is concluded that the thermal conductivity of glycine is 0·013 Joules cm/cm² sec °C.

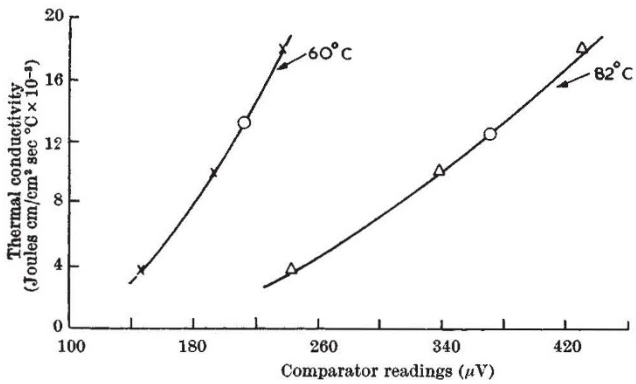

Fig. 1. Relationship between thermal conductivity and comparator readings. Circles denote glycine readings.

The implication of such a low value is that conduction in this material is predominantly by means of the lattice. (It is reasonable to assume that other aliphatic amino-acids will have comparable thermal conductivities.) Thus the absorbed energy cannot readily be evenly distributed throughout the whole sample, but tends to remain close to the point of deposition. This results in the local heating and radical reactions postulated to account for the electron spin resonance data.

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MOLECULAR STRUCTURE

Bonding Radii of 80S Ribosomes

THERE are now clear descriptions of the packing of ribosomes from two different nucleated organisms into two different crystal forms. One form, the chromatoid bodies of *Entamoeba invadens*, is a hexagonal array of helices[1]. The other form, found in mitotic cells of chilled chick embryos, consists of tightly packed layers of plane lattices[2]. At first sight there is no apparent relation between the packing of ribosomes within these two forms. We will show, however, that there is a way of looking at the bonds which these ribosomes form which closely relates one packing scheme to the other.

Byers[2] has shown that the ribosome crystals found in chick embryos belong to the space group $P422$. His micrographs show that the ribosomes are not in the general positions of this space group, but rather in very special ones. Fig. 1*a* gives a view of this packing perpendicular to the four-fold axes. Nothing in the symmetry of the space group demands that the distances marked d_1 and d_2 in this figure should be equal. Yet they are. By using either this property, or the equivalent one that ribosomes fall along mutually perpendicular families of lines, one can find, by algebraic geometry, that the special positions occupied by ribosomes in this particular lattice are described by the co-ordinates $x = 3/10a$ and $y = 1/10a$, where a is the length of the square face of the unit cell, 540 Å. As a consequence α, the angle between centres of the ribosomes and the cell edge, is arc $\tan(y/x) = 1/3$ or 18·4°, as Byers has observed.

Fig. 1*b* shows a section of the same packing parallel to the four-fold axes and through the ribosomes marked I in Fig. 1*a*. Again note the symmetry of the space group does not demand that the distances marked d_3 and d_4 should be equal. Yet they are, and so we deduce that the special value of the z co-ordinate is $z = \frac{1}{4}c$, where c, the height of the unit cell, is 700 Å.

Given these co-ordinates of any ribosome in the crystal, it is easy to compute the centre-to-centre distances between nearest neighbours. In the planes (Fig. 1*a*), these neighbours are 240 Å apart, as Byers has noted[2], while between planes (Fig. 1*b*) nearest neighbours are 366 Å apart, and situated along lines making an angle β of 17·1° (that is, arc $\tan = y/z$) with the long edge of the cell. The ratio of these two closest approaches is 1·5.

When we use these numbers to define the lengths and directions of what we call the "effective bonding radii" of these ribosomes, the resulting pattern is pictured in Fig. 2*a*. We may describe its construction as follows. (1) A bonding site of radius 120 Å occurs along the equator of three meridians: 0°, 90°, 180°. Call these s_1, s_2, s_3.