Surface Free-Energy of Solid Paraffin Wax

As part of a programme of research on the surface free-energy of solids, we have lately been working on paraffin wax. The method used is the one proposed by Bergegren and consists in measuring the rates of elongation or contraction of thin filaments of different lengths hanging under their own weights. The change in length is found from two opposing forces: one of which tends to shorten the filament so that its surface free-energy is decreased, and the other tending to lengthen the filament because of its weight. A critical filament-length, \( l_0 \), is determined at which the elongation of the upper part of the filament is equal to the contraction of the lower part, so that the length remains constant. Assuming that the solid near the melting point behaves as a viscous liquid, that is, the rate of deformation is proportional to the applied stress, the surface free-energy of the solid can be calculated from the critical length \( l_0 \) using the equation:

\[
\gamma = \frac{1}{2} \rho g l_0^2
\]

where \( \gamma \) is surface free-energy, \( \rho \) is density of solid at temperature of experiment, \( g \) is acceleration due to gravity, and \( l_0 \) is radius of wire.

In our experiments, filaments of 0.01088 cm. radius were produced by extrusion of the paraffin wax (melting range 54–56°C) through a tungsten carbide die at room temperature into a constant-temperature (± 0.1°C) enclosure. The filaments were then made on the filament hanging from the die. The change in length was measured at intervals by means of a cathetometer, and \( \Delta l/\Delta t \) (positive or negative) plotted against the original length of the filament. This should be a straight line according to theory, and \( l_0 \) was obtained by interpolation as the intercept on the length axis.

Measurements were carried out at 29.5°C, 36°C, and 41.5°C, and the surface free-energy calculated using \( \rho_{20°C} = 0.8857 \text{ gm./cm}^3 \), the change in density being negligible over the temperature-range concerned. The results are plotted in the accompanying graph, together with values for the same specimen of paraffin wax in the liquid state determined by the ring tensiometer method and corrected by the method of Hardman and Jordan.

The results indicate a discontinuity in the surface free-energy on melting. On the other hand, the temperature coefficient of the surface free-energy does not alter appreciably.

A Device for Counting Small Particles suspended in a Fluid through a Tube

Attempts to count small particles suspended in fluid flowing through a tube have not hitherto been very successful. With particles such as red blood cells the experimenter must choose between a wide tube which allows particles to pass two or more abreast across a particular section, or a narrow tube which makes microscopic observation of the contents of the tube difficult due to the different refractive indices of the tube and the suspended fluid. In addition, narrow tubes tend to block easily.

These difficulties can be overcome by slowly injecting a suspension of the particles into a faster stream of fluid flowing in the same direction. Provided there is no turbulence, the wide column of particles will then be accelerated to form a narrow column which will not interfere with observation of its axial contents. This principle has been applied to the alignment of red blood cells preparatory to electronic counting.
The whole apparatus is filled with gas-free distilled water which is allowed to flow via tubes 2 and 2a into the wide tube 4 and into the vortex 5. Tube 6 is normally closed. The suspension of cells is then passed into the needle (1). As the stream of cells emerges from the tapered tip of the needle it is narrowed by the faster peripheral stream in 3, and as the vortex is approached the stream of cells narrows further as the velocity increases.

To be robust and serviceable, the chamber is made of a solid brass block, drilled and tapered so that all the five tubes can be removed for cleaning or replacement. Three side tubes are used. By using tubes 2 and 2a for water to enter the chamber, the stream of cells passing from the needle to the vortex loses its tendency to curve which occurs if water enters from one side only.

Tube 6 is connected to a source of negative pressure. It is normally closed, but it is useful for flushing air or foreign material from the chamber.

The needle, which is circular in cross-section, approaches a square cross-section at the observation area (4). Here the walls are cut away and replaced with flat glass cover-slips sealed to the brass with wax compound. Ideally, tube 3 should be tapered and, from the point of view of accelerating the cells, rather narrower than it is. The needle and vortex are aligned as accurately as possible to be central to the side bore.

The needle should be wide enough not to block easily but, provided it does not block, should be as arrow as possible to enable the velocity of cells passing through the needle to be substantially greater than the sedimentation effect of gravity. A further

**Drawing Synthetic Fibres**

There are two aspects of the drawing of synthetic fibres which have not so far been treated very fully in the literature. These are, respectively, the behaviour of the fibre during continuous Drawing on the machine (as opposed to simple stretching on a tensiometer) and the formation and maintenance of a ‘neck’ during drawing. These two problems are intimately related to one another, since a continuous drawing machine, operating as a steady-state tenso meter, is a particularly suitable tool for producing ‘necking’.

The starting point was to consider continuous machine drawing in terms of a three-dimensional load-extension-temperature surface characteristic of the material, which makes it possible to depict the results of our investigation has been polyethylene terephthalate ('Terylene'). A 'contour map' for such a surface for the material is shown in the accompanying graph.

It has been found that during continuous drawing between two rolls, with a heater mounted between, the extensions occurring in the yarn at all points in the thread-line can be explained in terms of this surface, whenever the yarn tension is less than that required to form a ‘neck’ in the cold fibre. Most of this region lies above the second-order transition temp-