

Slough, concerning the design of very large cameras in which completed metallurgical products can be examined for measurement of internal stress.

The discussion on applications brought out the very great diversity of subjects now being investigated by X-ray methods. Bunn of Imperial Chemical Industries, Ltd. (Northwich), in his remarks emphasized the need for the production of an index of the known structures of chemical compounds, etc., as this would be a great help in the identification of compounds. This question was the subject of further comment by other speakers, and was referred to the organizing committee of the Conference with the view of promoting active steps to provide an index for X-ray workers.

The final discussion was concerned with the correlation of X-ray structure of metals and mechanical properties. Numerous speakers indicated how industry is developing this subject in connexion with such problems as the measurement of internal stresses and preferred orientation in strip and wire, and on the theoretical side Sir Lawrence Bragg showed how the measurements by Wood on the limiting crystallite size of metals can be used to estimate in a simple way their yield strength within very reasonable limits.

On April 10, Sir Lawrence Bragg delivered a lecture entitled "The History and Development of X-ray Analysis." This was a very enjoyable feature. It commenced with a fascinating account of the early work of himself and his father, the late Sir William Bragg, and after tracing the major developments up to the present time, ended with a statement of various problems, such as the structure of proteins, the 'fine' structure of deformed metal, etc., which were in his opinion on the threshold of solution.

As a result of the interest displayed at the Conference and the enthusiasm of the members, a resolution was passed suggesting that the organizing committee should take steps to set up a permanent organization under the aegis of the Institute of Physics to arrange similar conferences from time to time.

## CRYSTALLINITY IN CELLULOSE ESTERS

ACCORDING to an article by W. O. Baker (*Bell Lab. Rec.*, 20, No. 6, Feb., 1942) the toughness, strength and flexibility of plastics are influenced by the arrangement as well as the composition of their giant molecules. In an endeavour to discover the fundamental properties of certain compounds such as cellulose acetate and cellulose butyrate, which make these materials resistant to shock, bending, twisting and dimensional change, studies were undertaken on a molecular scale, the high magnification necessary being obtained by photographing X-ray beams after passage through selected samples of the plastics. These photographs give patterns which can be measured to show molecular distances as small as a billionth of an inch, and they also indicate how the molecules are placed with respect to each other.

A minute cylindrical beam is passed through small flat sections about one millimetre thick, much of it expanding into coaxial cones on account of diffraction by the layers of molecules. After an exposure of three or four hours, circular records appear on the photographic film, the degree of crystallinity being indicated by the sharpness and number of circles recorded. In striking analogy to metals, it was

found that the cellulose esters could be quenched by rapid cooling from the molten state. The long polymer molecules were then found to be disordered with respect to each other. Neighbours of a given molecule are quite randomly arranged although there is a tendency for sections of the chains to lie side by side. When cooled slowly, however, the molecules have a very ordered arrangement in local regions throughout the plastic. When they have the maximum disorder, the material tends to be most soft and flexible, and when they are most ordered, or crystallized, it is hardest and strongest, but sometimes brittle.

Two other methods of controlling the number of organized and disorganized molecules have long been used as working procedures in the technology of cellulose plastics. The first is to control the shape of the cellulose ester molecules by the amount of the reaction and the nature of the substituting groups so that they can only partially fit together, to give an ordered arrangement. The second, applying chiefly to lacquers such as aeroplane dopes and film formation, is the selection of a particular solvent which evaporates as the cellulose ester film dries. Various liquids were found to cause different amounts of molecular disorder in the resulting films.

The study showed that sections of the plastic's molecules could orient themselves in an ordered position in the solid state and that they undergo considerable torsional motion under the influence of temperature. Thus, it was possible to anneal quenched cellulose esters, and X-ray patterns show how this process causes the chain molecules to take up ordered positions. This ability of molecules to move in plastic solids even at ordinary temperatures appears to be closely related to their plasticity and capacity to bend and return to original form.

## DEVELOPMENTS IN ADULT EDUCATION\*

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DESPITE all that has been done in the field of educational psychology adult education has still only an empirical basis. There has been practically no research in Great Britain and very little in the United States. Yet without such careful inquiry it is not possible to plan effectively the great extension of the movement that is desirable after the War or to develop the necessary variety of methods. The first stage is to determine the problems to which the attention of psychological investigators should be directed. The educational activities now so widespread among men and women of H.M. Forces should yield valuable data and suggestions.

It must be remembered that nothing like simple extension into this constituency of work on conventional lines was feasible. The opportunity was, and is, immense. But conditions as a rule prevent the systematic, continuous study and the maintenance of academic standards which characterize the courses and classes carried on among civilians in peace-time by university extra-mural departments and organizations such as the Workers' Educational Association. On the other hand, a very small percentage of the

\* Substance of an address to the Education Section of the British Psychological Society at its Extended General Meeting, Brighton, April 10, 1942.