

seems likely that some segregation of foreign atoms must occur; various techniques are being used in an attempt to detect it. The phenomenon of intergranular brittleness also occurs in copper-antimony alloys at both high and low temperatures with an intermediate temperature-range in which brittleness does not occur.

The Division has commenced a new investigation on the mechanism of fatigue. It is known that certain changes may take place in the lattice structure during fatigue, and attempts to detect such changes at an early stage in the process are now being made by focusing a fine beam of partially monochromatized X-rays on a small area in which repeated slip is occurring. Thin specimens are used permitting the photographic observation of the low-angle scattering of the transmitted beam. Initial observations on copper have shown a very characteristic low-angle pattern produced in conditions of fatigue, and this can be interpreted in terms of changes of density occurring in the slip plane.

A mechanical fiducial indicator for fitting to proving rings has been developed by the Metrology Division. This not only facilitates the setting of the micrometer screw but also shows at a glance if the deflexion is changing and thus indicates if the load is subject to vibration or creep. Although the wavelength of light is now used for many precise length determinations, line standards and scales are still of fundamental importance, and an investigation is proceeding on their intercomparison by photographic means. A graduation line is a shallow groove, and the density of its photographic image falls off gradually as one moves across it. However, the maximum change of density is well defined and is independent of both the characteristics of the emulsion and its processing. By observing the density gradient with a microphotometer, it is hoped to compare two standards to an accuracy of a few hundred thousandths of a millimetre.

One item of considerable contemporary importance was a comparator for measuring the pitch errors of the fir-tree-root serrations of gas turbine blades. The blades are mounted in such a way that measurement of the vertical heights above a datum formed by the lowest serrations gives the spacings rapidly and with high accuracy.

To meet the requirements of organizations doing research at low temperatures, the Physics Division is arranging to make liquid helium for them in its Collins cryostat. Up to 15 litres will be supplied in double 'dewars' cooled with liquid nitrogen, and the helium gas evolved in use collected for re-liquefaction. The Division has just completed the most comprehensive series of experiments yet conducted for the determination of equal-loudness contours for the human ear. This work was carried out at the request of the British Standards Institution, and the results should form an acceptable basis for a new standard in subjective acoustics.

Recent increased demand for heat insulation at low temperatures has resulted in the development of appropriate apparatus to measure the thermal conductivities of various materials. The heat flow is from a source at room temperature to a sink cooled by liquid nitrogen or solid carbon dioxide. Samples of materials such as fine fibred glass, expanded plastic and lightweight powder have already been tested.

The Ship Division demonstrated a new apparatus which determines the rate of saturation of air from

bubbles in water, information on this being required for the design of cavitation tunnels. Another new development is the use of radio-controlled models to study the manoeuvring characteristics of ships. The system demonstrated operates on a carrier frequency of 465 Mc./s. with nine audio channels each feeding a change-over relay. The relays control three star-wound repeater motors which drive the rudder and two selector switches controlling the speeds and directions of the two propulsion motors. The rate of operation of the shore controls is limited to scale speeds by centrifugal governors.

Midwives may now administer trichloroethylene B.P. as an analgesic with inhalers approved by the Central Midwives' Board, which issues a certificate of approval of satisfactory apparatus valid for six months. The National Physical Laboratory has undertaken the testing of the inhalers to the specification of the Medical Research Council, and the Test House has set up a new section for this purpose. Temperature-controlled boxes each hold four inhalers, and the trichloroethylene-air mixture is drawn from them by a special pump with an adjustable rate which simulates human breathing. For the high accuracy required, a Rayleigh refractometer is used for the volumetric analysis; other tests include the measurement of resistance to airflow and mechanical inspection.

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## BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION

### OPEN DAYS

THE British Non-Ferrous Metals Research Association is this year celebrating the twenty-fifth anniversary of the opening of its own laboratory premises at Euston Street in London. The occasion was marked by a visit from H.R.H. the Duke of Edinburgh on May 23, and for the remainder of the week the laboratories were open to the representatives of member firms, government departments and others.

The original laboratory block in Euston Street was almost completely destroyed by enemy action during the Second World War; but it has since been rebuilt and now houses most of the Association's general metallurgy work and its metal-working plant. The laboratories have, however, been expanded considerably into adjacent blocks of buildings and now cover a floor area of about 43,000 sq. ft. and house a staff of about a hundred and fifty. The exhibition of work in connexion with these open days covered a very wide range of subjects, and in this short note it is only possible to refer to a few of those having a more purely scientific appeal.

For some years now the Association has been investigating the causes of the pitting corrosion of copper water-pipes which occurs in certain localities in Great Britain. Pitting corrosion is comparatively rare and usually affects only a few installations in any particular area. It has been found to be associated with cathodic films occurring under certain circumstances in the bore of copper pipes. The fact that pitting corrosion is rare is probably due to the presence of a natural inhibitor in many supply waters, and a great deal of work has gone into the separation of this inhibitor and in attempts to identify it.

The method of isolating the inhibitor consists in evaporating water under reduced pressure to produce a concentrate of the inhibitor. The inhibitor is precipitated from this as a copper salt, and a hydrochloric acid solution of this precipitate is extracted with ether. Distillation of the solvent leaves a crude concentrate of inhibitor which is then subjected to vacuum sublimation. Paper chromatography has been used for attempting to identify the constituents in this crude inhibitor and to compare these constituents with known substances. The stage has now been reached when substances reacting in the same manner as the extract of natural inhibitor have been shown to inhibit pitting corrosion of copper when added to water in quantities as small as the amount of natural inhibitor present in many water supplies.

Another interesting exhibit concerned the use of ion-exchange resins for analytical work. These are now being used extensively in the Association's laboratories for facilitating the analysis of electroplating solutions and for general metallurgical analysis. One example is the accurate determination of the amount of trivalent chromium in chromium-plating solutions. The method in common use involves titration of the hexavalent chromium of one sample and, after oxidation of another sample, titration of the total chromium. The trivalent chromium content is given by the difference between the two titrations, and this may sometimes be as little as 0.2 ml., so that small errors in measurement can easily give a misleading result. Using an ion-exchange column, the small amount of trivalent chromium present can be separated from the hexavalent chromium and titrated with ferrous ammonium sulphate of appropriate strength. The solution is passed through a column which retains the trivalent chromium. After washing the column with water to remove all the hexavalent chromium, the column is eluted with dilute sulphuric acid and the solution of trivalent chromium so obtained oxidized and titrated.

It is of interest to note that the laboratories have also recently built a demineralizing plant for the production of water for use in analytical work. The plant consists of an ion-exchange column with a mixed bed of anion- and cation-exchange resins. It will produce about 80 gallons of water between regenerations at the rate of about 10 gallons/hr. The water is purer than that obtained from ordinary laboratory stills, and running expenses are considerably below those of electric stills.

The mechanical testing section of the laboratories has recently developed a short-term fatigue test enabling a rapid assessment to be made of the endurance limit of many materials. The test is based on the Wöhler type of fatigue machine; but the load is applied by means of a spring. The load is gradually increased during the course of the test by extending the spring, using a slow-motion drive from the main drive of the fatigue machine, and the specimen is broken in a period which may range from four or five hours up to about a day. The extension of the spring at the moment of failure gives the 'dynamic breaking stress' for the specimen, and it has been found that, for lead alloys, copper alloys and steels, there is a direct correlation between this stress and the endurance limit of the material. The test is likely to expedite considerably the exploration of the fatigue properties of new materials.

The development of a non-destructive method for measuring the thickness of electroplated coatings has long been needed by the plating industry. This

problem has recently been solved in the Association's physics laboratory using a method based on a thermoelectric effect. A heated probe is applied to the surface of the electroplated specimen, and a cold probe is placed on the coating at some short distance away. The interface between the coating and the basis metal under each probe can be considered analogous to the hot and cold junctions of a thermocouple, and the e.m.f. generated is amplified and measured on a galvanometer. The reading obtained is proportional to the thickness of coating for any given coating-basis metal combination and, if necessary, the instrument can be calibrated to read directly in terms of coating thickness. Already several firms have made extensive field trials with the equipment, and arrangements have been made for two firms of instrument manufacturers to produce it commercially.

In the physics laboratory there has also been shown a method for vacuum-etching metallographic specimens, which is used where ordinary chemical or electrolytic etches have proved unsatisfactory. In this method the specimen is made the negative electrode and is etched at 1,000–4,000 V. in argon at a pressure of 1–100  $\mu$  of mercury. The etching time has been found to vary from fifteen minutes to several hours according to the nature of the specimen. It appears to yield particularly good results on some aluminium alloys, such as the aluminium–1½ per cent manganese alloy, and has also been used for revealing grain boundaries in copper which could not be seen by ordinary etching techniques.

One exhibit in the general metallurgy section of particular interest to the fundamental scientist concerns work which the Association is carrying out on the properties of grain boundaries. For this work bi-crystals of copper, the orientations of which with respect to each other are known, are being subjected to shearing forces tending to move one crystal relative to the other. The magnitude of these forces is such that at the test temperature plastic deformation of the crystals themselves is negligible. Optical interference methods are being used for tracing the relative movements of the crystals, and by this technique movements as small as 500 Å. can be observed. Eventually it is hoped that this work will give an indication of the part which grain-boundary movement plays in the behaviour of metals in slow creep.

## THE WATER POLLUTION RESEARCH LABORATORY, STEVENAGE

THE Water Pollution Research Laboratory—one of the fourteen research stations of the Department of Scientific and Industrial Research—was set up in 1927. Until recently it had no permanent buildings of its own, and its work was carried out in a number of temporary laboratories in different parts of Britain. The official opening on June 20 of a permanent central laboratory at Stevenage therefore marks an important stage in the history of the organization.

In 1927 there were many urgent and serious problems of pollution of surface waters, particularly by industrial effluents, and indeed the organization was formed as the result of representations made at that time to the Lord President of the Council by a