ASBESTOS

Biological Effects

from a Correspondent

A WORKING group to review the biological effects of asbestos was held under the auspices of the International Agency for Research on Cancer at its new headquarters building in Lyon between October 2 and 5.

Asbestos is one of the most important air pollutants, and is widely used throughout the world for insulation, fireproofing, construction and other purposes. Inhalation of asbestos can lead to asbestosis, a fibrous reaction that impairs lung function, and to an increased risk of cancers arising within the lungs (bronchogenic carcinomas) or from the layer of cells lining the pleural and peritoneal cavities (mesotheliomas).

A great deal is known about the physics and chemistry of particles of the different asbestos fibre types that are widely used commercially: chrysotile, crocidolite, amosite and anthophyllite. The size and shape of the particles vary, and this affects the site of deposition in the lungs after inhalation. Thus crocidolite fibres from the North-west Cape Province of South Africa are straight and fine, and they penetrate into the terminal air passages more readily than the thicker crocidolite fibres from the Transvaal or the curly fibres of chrysotile. Studies with asbestos made radioactive in a nuclear reactor have enabled Dr A. Morgan (UKAEA, Harwell) and his colleagues to obtain useful information about the sites of deposition and fate of different fibre types.

The identification of different fibre types in small amounts, such as residues from lungs, has presented difficulties. Electron diffraction patterns of single fibres, however, allow ready distinction of chrysotile from amphiboles. Dr V. Timbrell (MRC Pneumoconiosis Unit, Penarth) has found that the amphiboles crocidolite and amosite, which are very similar in chemical composition and many other properties, can be distinguished by the preferred orientations which they exhibit in a magnetic field. Crocidolite is paramagnetic, so the fibres become aligned parallel to the field lines, whereas amosite, which is diamagnetic, aligns with fibres normal to the field lines. Using light scattering of aligned fibres in liquid suspension, quantities of the order of 1 μg can be resolved.

The biological effects of asbestos have been studied in cultures of macrophages and other cells, and in organ cultures of lung or pleura. Because of their length, asbestos fibres are often incompletely phagocytosed. Chrysotile is more haemolytic and cytotoxic than other asbestos types, and as pointed out by Dr A. C. Allison (Clinical Research Centre, Harrow), the cytotoxicity can occur early, because of interaction with the plasma membrane, or later, as a result of disruption of the lysosomal membrane. The concentration of magnesium ions on the surface of the particles seems to play an important part in the interaction with the constituents of membranes, mainly glycoproteins. Dr K. T. Rajan (Penarth) reported that asbestos added to cultures of human pleura induces a proliferative reaction in mesothelial cells.

Epidemiological studies carried out in several countries have produced strong evidence of association between asbestosis and exposure to all types of asbestos, both in the production and manufacture of asbestos products and in their use for insulation or other purposes. There is no clear evidence of differences in the ability of various fibre types to produce asbestosis, but the disease occurs at a very high rate when there is particularly intensive exposure, as is the case for textile and insulation workers. The same relationships probably exist for carcinoma, with no important differences in risk from different fibre types, and again high rates in textile and insulation workers. The risk of carcinoma in asbestos workers is greatly increased by cigarette smoking, but whether the two effects are additive or multiplicative is not yet certain. For mesothelioma an even more extreme difference occurs between insulation and textile workers as compared with others, and there is a strong suggestion that crocidolite is especially related to this type of tumour. There is, however, some evidence that chrysotile is not wholly free of risk in either production or utilization.

The effects of asbestos and other fibres on experimental animals, reviewed by Drs J. C. Wagner and G. Berry (Penarth) and Dr M. F. Stanton (Bethesda), correspond quite well with the epidemiological evidence of the effects of human exposure. Inhalation of the various fibre types results in pulmonary fibrogenesis and an increased incidence of bronchogenic tumours in animals. Intrapleural inoculation of all four principal types of asbestos fibre results in the induction of mesotheliomas in rats. Hence the low incidence of mesotheliomas in humans exposed to fibres other than crocidolite is probably a consequence of the relatively poor penetration of these fibres to the pleura and retention within the pleura.

Stanton reported that borosilicate glass and aluminium oxide fibres comparable in size to respirable asbestos, implanted in the pleura of rats, result in a high incidence of mesotheliomas, whereas larger or smaller fibres are less carcinogenic. These and other observations focus attention on the length and diameter of the particles rather than their chemical composition as important

Photoelectron Spectroscopy and Oxide Films

IN next Monday's *Nature Physical Science* (December 4) Hoar, Talerman and Sherwood describe the application of a new technique, photoelectron spectroscopy, to the study of a long-standing but largely unresolved problem, the oxidation of iron surfaces. The technique, widely referred to as "ESCA" (a contraction of electron spectroscopy for chemical analysis, relies simply on the photoelectric effect, whereby electrons are emitted from the surfaces of solids (or from gases) when irradiated by photons of energy greater than the work function.

Modern instruments, such as that referred to in this study of iron, employ aluminium or magnesium X-rays as the excitation (the sharp Kα emission line) and the photoelectrons are analysed electrostatically. This gives an energy spectrum of both core and valence levels for each element within approximately 10 nm of the surface. Such a "fingerprint" for each element, however, contains additional information concerning its chemical environment, inferred from the chemical shift (that is, the change in electronegativity on bonding) in the binding energy of the core levels. Hoar and his colleagues have used this facility to determine the charge state of the iron in oxide films on pure iron and an iron–1.56 per cent aluminium alloy. The shift in the Fe-3p peak in fact indicates that the oxide on pure iron is Fe_2O_3 and that on the alloy is Fe_3O_4. This observation clearly illustrates the usefulness of this technique in the field of corrosion, and indeed indicates its potential value in the study of any surface-chemical phenomenon.

Within this broader context, work is actively under way in many laboratories on such topics as heterogeneous catalysis, fracture and frictional phenomena, semiconductors and metals, and molecular chemistry (the latter in both solid and gaseous phases). The problems encountered vary from those of great practical importance, for example, catalysts for the control of motor car exhaust pollution, to those of esoteric theoretical significance in the study of the band structures of solids or bonding in coordination complexes.

Relatively few biological applications have so far been reported, although a group at the University of Nottingham plan to exploit the technique in the examination of teeth and their decay (essentially a surface phenomenon). There can be no doubt, however, that further applications in similar fields, such as forensic science, will follow shortly.