GENERAL REMARKS

This one-hundred-and-eighteenth volume of the *IARC Monographs* contains evaluations of the carcinogenic hazard to humans of welding (welding fumes and ultraviolet radiation from welding), molybdenum trioxide, and indium tin oxide. Welding and indium tin oxide were accorded high priority for evaluation in the *IARC Monographs* programme by an Advisory Group that met in 2014 (Straif et al., 2014).

Welding fumes were classified as *carcinogenic to humans* (Group 1) by the present Working Group, an upgrade from the earlier classification of fumes as *possibly carcinogenic to humans* (Group 2B) in 1989 (IARC, 1990). Ultraviolet radiation from welding was also evaluated for the first time and classified as *carcinogenic to humans* (Group 1), in line with previous evaluations of ultraviolet radiation as a human carcinogen (*IARC Monographs*, Volume 100D; IARC, 2012). Molybdenum trioxide and indium tin oxide had not been previously evaluated by the *IARC Monographs* programme.

A summary of the findings of this volume appears in *The Lancet Oncology* (Guha et al., 2017).

Indium tin oxide

Indium tin oxide is used in the production of liquid crystal displays, touch screens, solar panels and photovoltaics (NTP, 2009). Exposure primarily occurs in occupational settings where indium tin oxide is produced or processed, or where elemental indium is recycled and recovered from indium tin oxide. Indium tin oxide became an occupational exposure of interest in the early 2000s, when a series of case reports from Japanese workers with interstitial pulmonary disease and pulmonary fibrosis related to indium exposure appeared in the literature (Homma et al., 2003; Taguchi & Chonan, 2006; Omae et al., 2011). Currently no data are available to estimate the number of people exposed to indium tin oxide, and there are no published observational epidemiological studies of cancer associated with exposure to indium tin oxide. However, the use, recycling, and disposal of electronics continues to increase worldwide.

Studies in vivo and in vitro have suggested that the generation of indium from the solubilization of particles (for example, indium tin oxide and indium phosphide), as well as the sintering of indium tin oxide, contribute to the lung toxicity and perhaps carcinogenicity of these particles. In a previously reported 2-year inhalation study, indium phosphide particles were carcinogenic to the lung and other tissues in male and female mice and rats, even at the lowest concentration tested (0.03 mg/m^3) and with a short exposure duration (22 weeks for 0.1 and 0.3 mg/m^3) (Volume 86; IARC, 2006). The increased potency of indium phosphide compared with indium

tin oxide particles with regard to toxicity and carcinogenicity may be due in part to the greater breakdown of indium phosphide to generate 'free' indium.

In the 2-year studies of inhalation with indium tin oxide, the lowest exposure concentration tested was 0.01 mg/m^3, which was one order of magnitude lower than the occupational exposure limit established by the American Conference of Governmental Industrial Hygienists (ACGIH) and the recommended exposure limit established by the National Institute for Occupational Safety and Health (NIOSH) for indium. In the 2-year studies with indium phosphide, 0.01 mg/m^3 was not tested. Despite this low exposure concentration for indium tin oxide, 0.01 mg/m^3 induced malignant tumours of the lung in male and female rats. Also, exposure to indium tin oxide at the highest concentration (0.1 mg/m^3) was only for a short duration (26 weeks), but induced malignant tumours of the lung in male and female rats.

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