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The Technical Guideline for Preventing Health Impairment of Workers Engaged in the Indium Tin Oxide Handling Processes

Section1 Purpose of the Guideline

This technical guideline is prepared for employers and provides recommended actions to prevent the health impairment of workers who are engaged in the production or handling of indium tin oxide (hereinafter called "ITO") and other indium compounds.

Section 2 Target Substance

Target substances under this guideline shall be respirable size aerosol[1] of indium and other compounds including ITO, metal indium, indium hydroxide, indium oxide, indium chlorides and other substances (indium compounds) (hereinafter called "ITO, etc.,") produced or handled during the process of production, use and recycle of ITO. Further, physical and chemical property, hazardous property and applications of target substances are given in the Reference 1 and typical operational process is given in the Reference 2.

Section 3 Management of Workplace Environment and Work Practice Management

To prevent workers from indium exposure in the workplaces of producing or handling ITO, etc, in indoor (herein after called "handling of ITO, etc.,"), employers are required to implement the following actions and measures.

1 measures to be applied in facilities and equipments

Take either of the following measures. Also refer to a few examples introduced in each measure.

(1) Install remote control operation or change to automated production and/or handling process.

Example)

- Change operational procedure to allow workers to operate from outside of the work place.
- Convert manual operations to mechanized system.

(2) Install facilities and equipments which can hermetically seal or segregate source dust.

Example)

- Cover the entire area of source of dust facilities and equipments.
- Take skillful approach in minimizing openings (windows, etc.) of source of dust facilities and equipments jigs and fixtures.
- Change shape of hoppers and chutes to prevent dust from dispersing.
- Cap every kind of containers.
- Separate and segregate a working place from surrounding areas with installation of vinyl curtains around a source of dust.

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1 Respirable dust is defined as dust captured by a particle size selector having the specified particle transfer characteristics by Article2, Paragraph2 of the Working Environment Measurement Standard or captured by other particle size collectors which can measure and obtain the same value as the one measured value specified by Article2, Paragraph2 of the Working Environment Measurement Standard, practically captured dust by a sampler which has the size selection capability of to capture particulates having a 50% cut point at 4 μm.

・ Narrow space of working places including area of the dust source as much as possible.
・ Locate source of dust facilities and equipments in segregated rooms and enter there only when required.

(3) Install local ventilation equipments.

Example)

・ Factoring in actual operational conditions and procedures in a workplace, select suitable local ventilation equipments and assess their effectiveness by referring to the following measures.
  —Minimize the inlet area to the extent as required.
  —Enhance the ability of dust collection applying HEPA filters and similar devices.
  —Maintain the required inlet wind velocity through openings of local ventilation equipments.
  —Carry out daily inspections including detecting the indication of problems in local ventilation facility and check the inlet wind velocity.

(4) Install push-pull type ventilation equipments

(5) Install facilities to keep the working place humid.

Example)

・ Change working methods to the wet process as much as possible.
・ Moisten and wet jigs and rags, then store them inside covered containers to prevent from drying.

(6) Other dust suppression measures.

Example)

・ Place adhesive mats (adhesive sheet) on the entrances of work places to prevent dust from coming out of the work place.
・ Place mats with washing brushes to wash shoe soles on the entrance of a work place.
・ Install air showers (in a front room) at the entrances of a work room.
・ Wear working uniforms and caps made of dustproofing material.

2 Work Practice management

Select a competent supervisor who leads work practice management in unit work places. Request a supervisor-in-charge strict adherence to the following actions.

(1) Select working positions, postures and methods to protect workers from exposure to designated substances.

(2) Prepare operational manuals and thoroughly publicize.

(3) Shorten exposure time of workers to designated substances

(4) Strict adherence to the rule of wearing protective equipments (in addition to respiratory protective equipments, wear protective eye glasses if necessary).

(5) Cleaning works

As a proper handling of scattering powder on a floor of ITO, etc.,, clean the floor area periodically to prevent the secondary dusting (also, including the work places operated by remote control or changed to automated process).

To prevent dust stirred up by exhausted air of cleaners during floor sweeping, centralized-dust collection large outdoor collectors can be one recommendable example to look for.

Also, instruct workers engaged in cleaning ITO, etc., or recovery of sticking designated substance inside of facilities and equipments to wear effective respiratory protective equipments.

Workers must wash their own working uniforms on site. Also use separate lockers for working uniforms and private clothes.

(6) Keeping work records

For workers who are engaged in handling ITO, etc.,, name of the workers, period of the handling time of designated substances, summary of the handling works and use of the respiratory protective equipments must be recorded and maintained for 30 years.

3 Measuring work environments and others.

(1) Measurement

In the case of indoor work places where production and handling of ITO, etc., are carried out (except places where workers usually do not enter thanks to the remote control operation or process automation), measure the concentration of designated substances in air once per less than six months in accordance to methods described in Exhibit 1 and take actions described in the following b) subject to the outcome of the measuring results.

(2) Required actions based on the measuring results

Target concentration criteria (to be called "target concentration"[2]) of respirable dust for the improvement of work place environment where ITO, etc., are handled is set as 0.01 mg/m^3 (as element indium) by taking account of the current control level at plant sites.

In case that measuring results of the concentration of ITO, etc., in air exceeds either the first evaluation value computed per Item 3 in Exhibit 1 or the values measured in accordance with B-method, it is required to take actions listed in the followings immediately and improve the work place environment.

a) Carry out the sealing of facilities and equipments.

b) Enhance the performance capability of local ventilation equipments and dust collectors.

c) Change the work processes and methods, thereby exposure of workers to the designated substance can be reduced.

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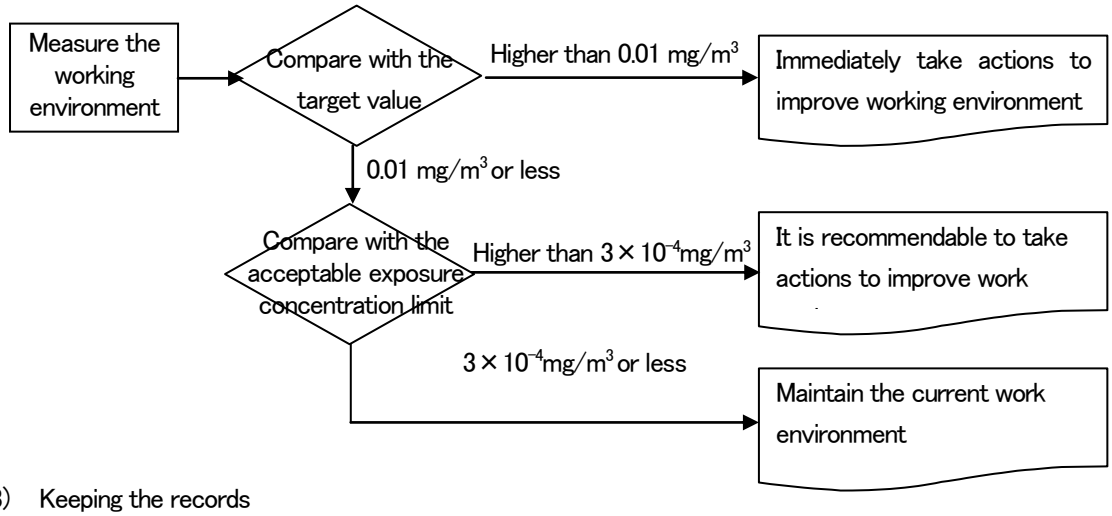
[2] Target concentration is a target of current efforts to improve the work environment and it is of different nature from the standard control concentration calculated under the work environment assessment standard.

However, even if the measured value was lower than the targeted value but exceeded the acceptable exposure concentration limit of 3×10^{-4}mg/m^3 that is a limit value calculated from the outcome of the test in long-term carcinogenicity studies in animals in this country, it is recommendable to take further actions as required continually to improve work environment and reduce the concentration of indium in air as much as possible.

If the 1st evaluation value or the value measured according with B-method exceeds the acceptable exposure concentration limit, then select and wear appropriate respiratory protective equipments following the procedures provided in Item 4.



(3) Keeping the records

Keep the measurement records of work environments for 30 years.

4 Use of the respiratory protective and other equipments

(1) In a work environment where measurement result exceeds the acceptable exposure concentration limit, workers engaged in handling ITO, etc., are mandated to select effective respiratory protective equipments complying with following guidelines and wear them during handling operations without exceptions.

As candidates of effective respiratory protective equipments, there are supplied-air respirators including JIS T8153 compatible air-supply respiratory protective equipment, dust mask capable of capturing higher than 99.9% particle collection efficiency or JIS T8157 compatible respiratory protective equipment equipped with an electric fan capable of collecting particles at higher than 99.9% efficiency. Also use dust masks certified under national standards.

(2) Select respiratory protective equipments with appropriate assigned protection factor in response to each work environment following "The Selection Criteria & Procedure for Respiratory Protective Equipments" of Exhibit 3 and based on the measured value per Item (3).

(3) Further, anticipating exposures during non-stationary operation or emergency situation, prepare and keep clean the required number of proper respiratory protective equipments to prevent workers from exposure to ITO, etc.,.

(4) At times to use dust masks, make sure the fitting to wearer's face with a fit-checker and select proper dust masks with a good fit. Also it is an effective approach to do the face fittings every time to wear a dust mask.

Section 4　Health management

1　Perform health checks

Perform health checks for workers engaged in handling ITO, etc., continuously by medical physicians at the time when they are employed, relocated to work places where said substances are handled and　thereafter once per within six months periodically　Same health checks should be provided to current workers with past work history of handling ITO, etc.,.

Items of health checks and procedures should follow the instructions given in Exhibit 4.

2　Follow-up actions to be taken after health checks

Employers must consult with a medical physician about results of medical checks per Item 1 above taking the following criteria as a guideline to determine the occupational classification for workers who had health checks. During consultation with a medical physician, points to keep in mind listed in Exhibit 5 that are helpful to assess the outcome of health checks should be referred.

Occupational classification	Results of health checks
Regular assignment	In the case of no findings of abnormality
Restrictions in working (Shorten　working hours, switch over to other working method, relocate to other workplaces or take a leave of absence from work for medical treatments, etc.)	In the cases of following findings 1　When indium in blood (to be called "serum indium concentration")　was equal to 3μ g/L or higher and a medical physician confirms the need for restricted working conditions. 2　If subjective and objective symptoms in respiratory system that are associated with interstitial pneumonitis or emphysematous change appeared, and measured value of sialylated carbohydrate antigen KL-6 (hereinafter to be called "serum KL-6 value") was equal to 500U/ml or higher, or examination by pulmonary function test or by special chest X-ray photograph (hereinafter to be called "chest computed tomography") showed abnormalities caused by indium, and a medical physician confirms the necessity of restricting work conditions.

Employer is required to determine actions for workers pursuant to the criteria of occupational classification and advice of a medical physician.

If restriction in working is imposed on workers, it might be appropriate to hear opinions from workers beforehand and provide them with sufficient information about health hazard and associated problems of ITO, etc.,, an effort to have their consent. Further in the case of plant site where the selection of an industrial physician is mandated, it is appropriate to hear opinion of workers with an attendance of an industrial medical physician.

Proposed actions for workers are aimed only to sustain health of workers and employers must refrain from discharging workers without enough care based on the opinions of a medical physician.

3 Keeping records of the health check results

Once health check is performed pursuant to Item 1 above, prepare the record of health check results per each worker and keep them for 30 years.

4 Reporting health check results

Once health check is performed pursuant to Item 1 above, report said health check results to the workers without delay.

5 Other issues to require attentions.

It is recommended employer to take the leadership in promoting non-smoking policy among workers who are engaged in handling ITO, etc., just because of the potential hazard causing pulmonary disorders.

Section 5 Occupational health and other educations

Employers are requested to provide workers engaged in handling designated substances with occupational health educations as listed here based on the information collected from this technical guideline, MSDS and others.

(1) Physical and other properties of ITO, etc.,.
(2) Symptoms and disorders caused by adverse effects or exposures to ITO, etc., together with meanings of acceptable exposure concentration limits calculated based on the testing results obtained from long-term carcinogenicity studies in animals.
(3) Target concentration and procedures described in the work rules.
(4) Instructions about how to use respiratory protective equipments
(5) Health checks and the way how to make the use of its results
(6) Other recommendations and rules to prevent potential health problems (recommended to include non-smoking policy).

If an employer assigns certain jobs to contractors and if workers other than employees are engage in handling ITO, etc., on site, said employer must provide the contractors with information described in above Item (1) through (4) and request them to take appropriate measures without exceptions to prevent their workers from suffering health problems.

Exhibit 1

Measuring Method of the Concentration of ITO, etc., in Air

Implement the procedures described below to measure the concentrations of ITO, etc., in air in the work environment.

1 Locations and the time zone to carry out measurements.

(1) Measuring points are between 50 ㎝ and 150 ㎝ above the crossing points of vertical and horizontal lines on the floor where the distance between lines should be 6m or less, and number of measuring points should be 5 or more per unit work place. Measurement should be performed during the working time while ITO, etc., are handled routinely (to be called "measurements according to A-measurement") .

(2) When handling designated substances is performed nearby from the source of dust, measurements of ITO, etc., are to be carried out again in addition to measurements instructed in Item (1) above (to be called "measurements according to the B-measurement") on the spot where handling work is taking place and at the time when the concentration of ITO and other indium compounds in air seems to have reached the peak.

2 Measuring the concentration

At each measuring point, measure the concentration of indium contained in ITO and other indium compounds as element indium. Also, subject to the level of measured indium concentration, it is possible to use other methods with comparable accuracy (for example, graphite furnace atomic absorption spectrometry for the target concentration)

(1) Capture respirable dust of ITO, etc., with filtration method, then measure the concentration as element indium by inductively coupled plasma mass spectrometry (ICP-MS). Also sampling time should be 10 minutes or longer.

(2) When dust is captured, only respirable dust should be collected separately because ITO, etc., are assumed to cause adverse effects once deposited in pulmonary alveoli.

(3) Use a sampler specifically designed for respirable dust (Examples: multi-stage parallel plate particle size selector, NW-354 Model, inertial collision particle size selector, NWPS-254, nylon cyclone separator or other suitable separators) and capturing respirable dust should be undertaken under the suction airflow rate described in user manuals of a sampler (Refer to Exhibit 2 for detailed measuring procedures).

3 Computation of measured results

Compute the 1st evaluation value by the Assessment Criteria of Working Environment (Ministry of Labor, Notification No.79 in 1988) from the concentration of indium in air measured in accordance with the A-measurement and compare it with target value and acceptable exposure concentration limit.

<Note 1>

Inductively coupled plasma mass spectrometry (ICP-MS) is a highly sensitive and efficient analyzer of inorganic element in solutions which comprises ICP to ionize metal plasma and mass spectrometer to separate and quantitate the ions. Its detection sensitivity is high and minute amount of indium can be quantitated.

Exhibit 2

Standard Analytical Method of Respirable Dust of ITO, etc.,

1. Measuring method

(1) Using a respirable dust sampler, respirable dust of cut-size 4 μ m diameter (50% efficiency) can be captured.

(2) To measure respirable dust, measuring time should be 10 minutes or longer each time and prescribed sampling flow rate should be maintained. Also, subject to the capability of an analyzer, it sometimes is recommended to prolong measuring time up to about 20 minutes per each time by taking account of the lower limit quantitaion (LOQ) of an analyzer.

(3) Captured dust is stored in a extraction solution that is mixed acid. Also it is confirmed that captured dust stored in extraction mixed acid solution at room temperature does not change the property until 15 days stored time.

2. Analytical method

Carry out analytical works by following the steps described below.

① Analysis should be carried out only for respirable dust collected on the filter, not for the whole captured dust.

② Dissolve each of captured dust in 15 ml of extraction mixed acid solution (ratio of water/nitric acid/hydrochloric acid=4/1/3) placed in a 200ml conical beaker.

③ Cover a beaker containing dust dissolved solution with a watch glass and raise temperature of said solution to 160℃ on a hot plate.

④ Take the beaker out of a hot plate once the dust dissolved solution was dried and evaporated to almost dryness (the volume of extracted liquid becomes a few drops) and leave it to cool down to the room temperature.

⑤ Then add 2ml of the extraction mixed acid solution again , cover the beaker cover with a watch glass, heat up another 30 minutes, then take it out of a hot plate once volume of extracted liquid becomes a few drops.

Also, in the midst of the heating to evaporate the dust dissolved solution, wash residues precipitated on the bottom of watch glass with ultra-pure water and add it into the beaker.

⑥ Once the beaker is cooled down to room temperature, add dilute 5% extraction mixed acid solution into the beaker to make up constant 40ml volume, then transfer it into a centrifuge tube.

⑦ Next, said solution is analyzed by ICP-MS and other apparatuses to quantitate the total indium.

○ Example of analysis by ICP-MS (Agilent7500i)

RF power	1400W
RF matching	1.7V
Carrier gads	Argon 1.0L/min
(m/Z) Measured mass number	115
Integration time	0.3sec (Repeat 3 times)
Calibration curve	Adjust a commercially available indium standard solution(1000μ g/mL) with diluted acid (5% mixed acid extraction solution) and confirm the linearity (r=0.99) of a calibration curve between 0 to 100ng/mL.
Compensation of the measured concentration	To compute the measured concentration, use the interference correction equation specified in EPA. Method 200.8 to compensate excess counts caused by molecular ions. (Interference correction equation) 115In＝(115C) × 1 － (118C) × 0.016 Note:(aC)is a counted number at mass "a"

Exhibit 3

Selection of respiratory protective equipments suitable for handling indium

– Reference table in case of the allowable exposure concentration of 3×10^{-4}mg/m^3–

Result of measured work environment (Determine based on the 1st Evaluation Value per work environment assessment criteria)	Guideline to Select Suitable Protective Equipments
Not measured* or 3×10^{-2} mg/m^3 or higher	"Protective equipment with potential filter efficiency of APF (assigned protection factor) 100 to 1000 level or higher " ·Covered area by face mask(full face) respiratory protective equipment with electric fan (particle capture efficiency 99.9% or higher) ·Full face and constant air flow type airline type mask ·Pressure-demand type airline mask
3×10^{-3} mg/m^3 or higher Target concentration	"Protective equipment with potential filter efficiency of APF (assigned protection factor) 50 to 100 level or higher " ·Covered area by face mask(half face) respiratory protective equipment with electric fan (particle capture efficiency 99.9% or higher) ·Replaceable type full face dust protective mask (mask with national test certificate: particle capture efficiency 99.9% or higher) (It is required a respiratory protective equipment wearer to do a fitting test periodically and confirm the leak rate less than 2% (assigned protection factor 50 or higher) by a mask fitting tester.)
Higher than 3×10^{-4} mg/m^3	"Protective equipment with potential filter efficiency of APF (assigned protection factor) 10 level or higher " ·Replaceable type half face dust protective mask (particle capture efficiency 99.9% or higher)
Acceptable concentration 3×10^{-4} mg/m^3 or lower	It is recommendable to wear protective respiratory equipments

* Works in a place where measurements of work environment are not performed.

- Special works in a place where occupational health engineering is applied and high concentration exposure is expected.
- Cleaning works of facility & equipment and others

Exhibit 4

Health Check Items for Workers Engaged in Handling ITO, etc.,

1 Health checks when workers are employed or relocated.

Employer must provide workers with health checks per following listed items by a medical physician when they are employed or relocated.

- Review job careers.
- Check the smoking. history
- Check the past medical history
- Check the past medical history of subjective symptoms such as cough, sputum and dyspnea and objective signs such as cyanosis, clubbed fingers caused by ITO, etc. exposure
- Check current subjective symptoms such as cough, sputum and dyspnea
- Check current objective signs such as cyanosis, clubbed fingers
- Measure the serum indium concentration.
- Measure the serum KL-6 value.
- Perform chest CT screening.

2 Periodical health checks

(1) Primary health checks

Employers must provide workers engaged in handling ITO, etc., with health checks at every six months or shorter intervals per following listed items by a medical physician.

- Review job careers.
- Brief survey of the work condition.
- Check the smoking.history
- Check the past medical history
- Check the past medical history of subjective symptoms such as cough, sputum and dyspnea and objective signs such as cyanosis, clubbed fingers caused by ITO, etc. exposure
- Check current subjective symptoms such as cough, sputum and dyspnea
- Check current objective signs such as cyanosis, clubbed fingers
- Measure the serum indium concentration.
- Measure the serum KL-6 value.

(2) Secondary health checks

Employers must provide workers with observed suspected abnormality in the outcomes of the primary health checks and whom a medical physician confirmed the necessity to have the secondary health checks per following listed items.

- Review the work conditions.
- When a physician recognizes it as need, perform chest x-ray screening [1)], chest CT screening [2)], blood chemistry analysis such as surfactant protein D (Serum SP-D), pulmonary function test[3)], sputum cytology, and/or bronchoscopic examination.
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3 Health checks for relocated workers

Employer are required to provide workers engaged in handling ITO, etc., who had the past history of handling the same on a steady basis with health checks listed in Section (2) above by a medical physician. However, pay careful attentions to the following points.

(1) Brief review of the work condition is not required.

(2) Measurements of the serum indium concentration and serum KL-6 value can be extended to carry out once a year or once three years if a physician confirmed such measurements are not needed.

Note1) means chest x-ray screening specified in item (4) of paragraph (1) of Article 44 of the Ordinance on Industrial Safety and Health.

Note2) means screening of the whole-lung CT and upper lung field, middle lung field and lower lung field by HRCT (High-resolution CT) scanning. If confirmed by a medical physician, HRCT scanning can be excepted..

Note3) means measurement of vital capacity by a spirometer and flow-volume curve, carbon monoxide lung diffusing capacity and arterial blood gas analysis.

Exhibit 5

Points to Consider for the Evaluation of Outcomes of Health Checks

1 Serum indium concentration & serum KL-6 value

In some incident cases of pulmonary damages caused by ITO, etc., especially interstitial changes and emphysematous changes, the damages were observed to progress regardless workers continue handling of ITO, etc., and the emphysematous changes become worse year by year. Pay attention that subjective symptoms of pulmonary damages do not always appear in the early stage of diseases.

To detect the health effects of ITO, etc. in the early stage, the serum indium concentration and serum KL-6 value, a serum markers for interstitial pneumonitis, are known useful indicators..

Medical knowledge is just acquired that the risk of interstitial changes increases if the serum indium concentration is 3 μg/L or higher.

Also, the serum KL-6 value of 500 U/mL or highersuggests the onset of interstitial pneumonitis. However, the serum KL-6 value does not always show the higher value even after interstitial pneumonitis because of the influence of disease activity.. For example, the serum KL-6 value sometimes returns to the normal level in parallel with decreasing exposures and- healing interstitial inflammations but lung fibrosis and lung dysfunction sometimes persists..

Thus normalization of the serum KL-6 value means the decrease of active interstitial pneumonitis and it does not mean there is no pulmonary damage or interstitial changes already healed. Especially workers who reported the serum indium concentration of 3μg/L or higher in the past should be reminded of a possibility to develop the interstitial pneumonitis and emphysematous changes.

Because of the fact mentioned above, judgment of the lung damage should not be evaluated based on one time measured value of the serum indium concentration and serum KL-6 values, rather by observing trend of the serum indium concentrations measured during periodical health checks Especially, pay attention to the highest concentration level.

2 Chest CT Screening

It is pointed out that the finding of lung damage caused by ITO, etc., identified by the chest CT screening suggests the interstitial changes and emphysematous changes followed by interstitial ones. Interstitial changes and emphysematous changes occasionally appears in certain period of time after the serum indium concentration has increased, therefore it is recommendable that the necessity of chest CT screening as the secondary health checks for workers who had the findings of abnormal serum indium concentration in the past should be reviewed beforehand carefully.

Further when workers would have the chest CT screening during the secondary health checks, it is important to preclude the findings caused by other causes except smoking or ITO, etc. by comparing with CT images taken at the time of employment or relocation as basic data.

Reference 1

General Picture of Target Substances

1 Physical and other properties

(1) Basic information of chemical substance

Name	Indium tin oxide	Indium	Indium oxide	Indium trichloride	Indium hydroxide
Chemical formula	In_2O_3/SnO_2	In	In_2O_3	$InCl_3$	$In(OH)_3$
Molecular weight		114.82	277.64	221.18	165.84
CAS number	50926-11-9	7440-74-6	1312-43-2	10025-82-8	20661-21-6
Designated law	Appendix 9" Hazardous substance whose chemical name is required to report" in Article18-2 of the Enforcement Order of the Industrial Safety and Health Act				

(2) Physical & chemical property

Material name	Indium tin oxide	Indium	Indium oxide	Indium trichloride	Indium hydroxide
Appearance	Dark gray～Green solid	Silver white soft metal	Light yellow crystal	White crystal	White powder
Specific gravity (water=1)	Approx. 7.15 (In_2O_3:SnO_2= 64-100%: 0-36 %)	7.282(24 ℃)	7.179	3.46(25 ℃)	
Boiling point	℃	2072 ℃	850 ℃	Decomposition at 500℃	
Melting point	℃	156.6 ℃	No data available		Decomposition at approx.150℃
Solubility in water g/100ml(25℃)	Insoluble	No information	Insoluble	212	Insoluble

(3) Physical and chemical hazard

Material name	Indium tin oxide	Indium
Fire hazard	Not flammable	Not flammable
Explosion hazard	Not hazardous	Powder spreads in the form of minute particles to form explosive mixed gas.
Physical hazard	There is a good possibility to produce fume and gas at 1500℃ or higher (under reductive gas atmosphere or reduced ambient pressure, fume and gas can be produced at lower temperature)	There is a possibility to have a dust explosion if mixed with air in the form of powder or granule.
Chemical hazard	No information available	React with strong acid, strong oxidizer or sulfur leading up to fire or explosion.

(4) Applications

Material name	Application
Indium tin oxide	Transparent raw material of SED (Surface-conduction Electron-emitter Display) for personal computer, television and portable terminal device, touch panel and solar battery
Indium	Raw material of silver-alloy brazing, silver-alloy contacts, solder, low melting point alloy, liquid crystal cell electrode, dental alloy, anticorrosive aluminum, TV camera, germanium transistor, optical communication, solar power generation, electronic components, bearing metal and indium phosphide crystal.
Indium oxide	Raw material of ITO
Indium trichloride	Raw material of ITO
Indium hydroxide	Raw material of transparent electrode
	Raw material of indium oxide, indium nitrate, indium sulfate and battery electrode material

2 Toxicity

(1) Carcinogenicity

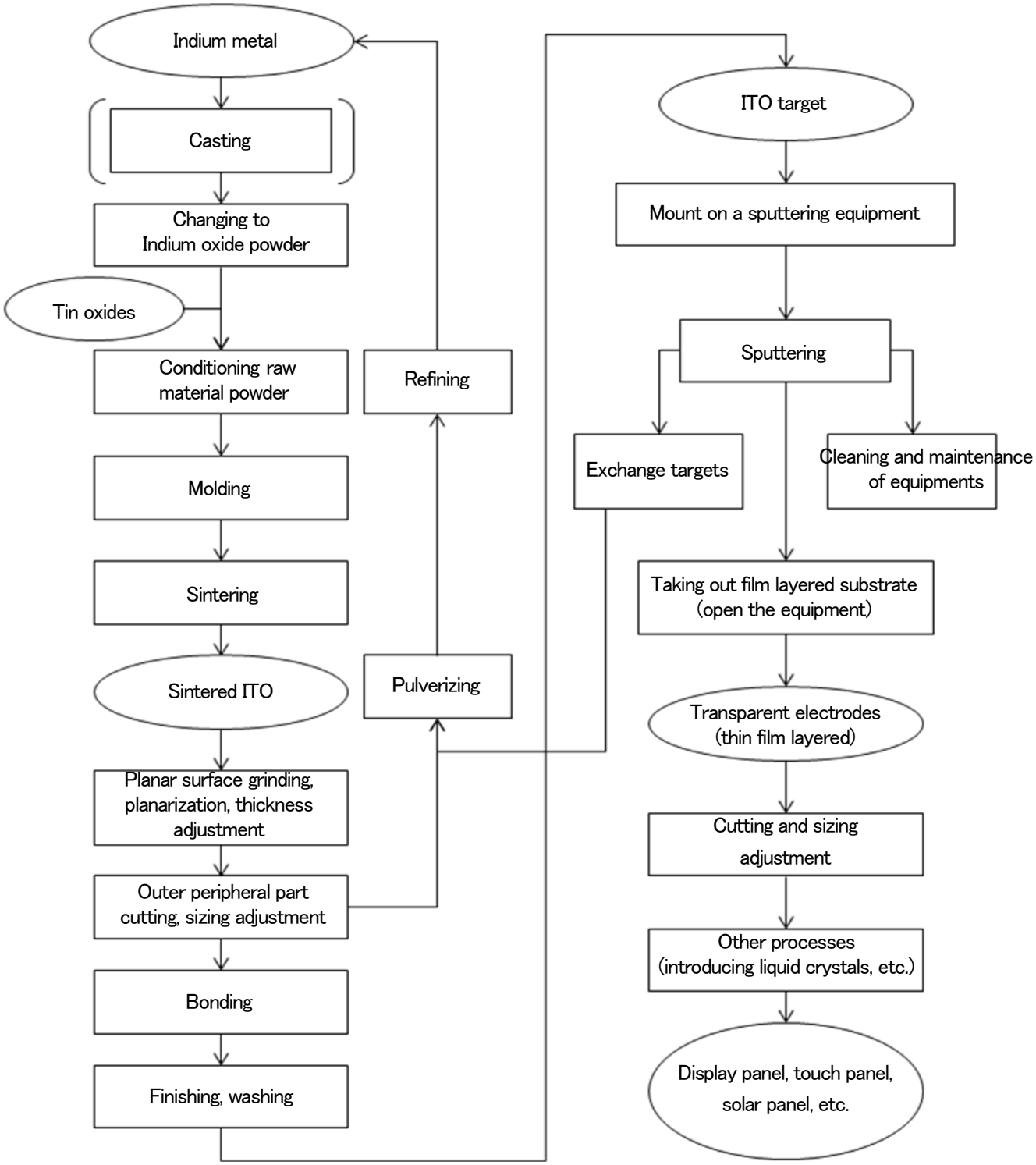
	Justification
Carcinogenicity	Probable Human Carcinogen ① IARC classified indium phosphide as Group 2A (probable) human carcinogen. Carcinogenicity of other compounds than indium phosphide is unknown but is thought indium as cause of carcinogen. ② In the carcinogenicity study by Japan Bioassay Research Center, rats of both sexes were exposed to the 0.01, 0.03 and 0.1mg/m^3 concentrations of ITO grinding dusts for 104 weeks. Growth and proliferation of small bronchial-alveolar cell carcinoma and small bronchial-alveolar epithelial adenoma were observed in the lungs of rats at the minimum concentration of 0.01mg/m^3. Further, adenosquamous carcinoma in the lung of male rats and adenosquamous carcinoma together with squamous cell carcinoma in the lung of female rats were identified Further mice were exposed to the same level of concentrations of ITO grinding dusts for 104 weeks, but no cancer identified.
Presence or absence of threshold value	Present Based on the outcome of exposure test, it can be assumed that persisted lung inflammation caused hyperplasia of bronchial-alveolar epithelial cells and eventually cancerous changes.
Risk level	3.0×10^{-4} mg/m^3 Calculation formula : 0.01 mg/m^3 (LOAEL) × 1/25 (UF) × 6/8 (work adjustment facor)=3.0×10^{-4} mg/m^3 LOAEL : Study by Japan Bioassay Research Center "Long term carcinogenicity by inhalation exposure to rats" UF : Conversion of LOAEL to NOAEL (10), Species difference (2.5)、

(2) Hazardous property other than carcinogenicity

Hazardous property	Details
Acute toxicity	LD_{50}> 10g/kg (rats、oral)
Skin corrosion/irritation	No reports available
Serious eye damaging/irritating property	Positive Soluble salts cause strong eye irritation
Skin sensitization	No reports available
Repeated dose toxicity(except reproductive and developmental toxicity/carcinogenicity)	Pulmonary edema, pulmonary alveolar proteinosis (rats) Pulmonary chronic inflammation (mice) (Reference) In the carcinogenicity study by Japan Bioassay Research Center, male and female rats were exposed to 0.01,0.03 and 0.1mg/m^3 ITO grinding dusts for 104 weeks. Growth and proliferation of pulmonary alveolar proteinosis, alveolar epithelial hyperplasia and fibrosis of alveolar walls were observed in the lungs of rats of both sexes at the minimum concentration of 0.01mg/m^3. Further, growth and proliferation of pulmonary alveolar proteinosis in the lung of female rats were identified [Trial calculation of acceptable exposure limit concentration] Result of trial calculation : 3.0×10^{-4} mg/m^3 Computation formula : 0.01 mg/m^3 (LOAEL) × 1/25 (UF) × 6/8 (work correction factor)=3.0×10^{-4} mg/m^3 LOAEL : Study by Japan Bioassay Research Center "Long term carcinogenicity by inhalation exposure to rats" UF : Conversion of LOAEL to NOAEL (10), Species difference (2.5)、
Reproductive toxicity	No information availability

Reference2

Ito and indium compounds handling work



Note: Sputtering is a method wherein high voltage is applied to the gap applied between substrate and target while introducing inert gas into a vacuum, and bombarding the target with a beam of ionized inert gas to eject atoms from the target surface to form a thin layer of the same substance on the substrate.

Especially a target made of sintered body consisting indium oxide and tin oxide is called "ITO target".