

## Original Articles

### ***Temperature hysteresis in charge–discharge process of $\text{LiMn}_2\text{O}_4$ spinel***

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*Journal of Power Sources 123, 48–52, 2003.*

Quasi-equilibrium potential profiles of stoichiometric  $\text{LiMn}_2\text{O}_4$  spinel in charge–discharge process have been recorded to investigate temperature dependence in lithium ions intercalation. Temperature of electrodes has been controlled within  $273 \leq T \leq 298$  K in this research. Discharge curve reveals anomalous stepwise features when both charge and discharge processes are carried out at low temperature ( $T \leq 278$  K). However, discharge curve at 273 K immediately after charge at 298 K does not show stepwise shape but gently slope as potential curve in charge at 298 K. In contrast to this, discharge curve at 298 K immediately after charge at 273 K shows stepwise anomaly. Temperature at discharge does not affect on shape of potential profile at next charge process. This temperature hysteresis has been confirmed repeatedly in several charge–discharge cycles. Temperature at Li ions de-intercalation has a large effect on next intercalation in  $\text{LiMn}_2\text{O}_4$  spinel.

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### ***Phase transition observed in potential–composition profiles of $\text{Li}_x\text{Mn}_2\text{O}_4$***

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*Journal of Power Sources 124, 526–532, 2003.*

Open circuit voltage (OCV) profiles of spinel type lithium manganese oxide  $\text{Li}_x\text{Mn}_2\text{O}_4$  ( $x \leq 1$ ) have been recorded at several temperatures ( $243 \text{ K} \leq T \leq 323 \text{ K}$ ) using a single three-electrode glass cell. Deintercalation of Li ions from  $\text{Li}_x\text{Mn}_2\text{O}_4$  has been carried out at low temperature (243 K), and then OCV profile has been measured at both the processes of raising and descending temperatures on each state of lithium content ( $x$ ). Quasi-equilibrium potential profiles above room temperature ( $298 \text{ K} \leq T$ ), which are results of continuous measurements by first charge, overlap with OCV profiles in the process of raising temperature well. However, around  $x=0.5$ , quasi-equilibrium potential profiles and OCV profiles do not overlap at low temperature ( $T \leq 278$  K). This result indicates that the low-temperature phase at  $x=0.5$  in  $\text{Li}_x\text{Mn}_2\text{O}_4$  is very sensitive to temperature change. Temperature dependence of OCV profiles in the process of descending temperature corresponds to a simulation based on assumption that distribution of Li ions is disordered in  $\text{Li}_x\text{Mn}_2\text{O}_4$  ( $0.5 \leq x < 1$ ).

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### ***Study of wet porous filtration***

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*Separation Purification Technology 30, 129–137, 2003.*

A growing demand for efficient air quality management calls for the development of technologies capable of meeting the stringent requirements now being applied in areas of chemical, biological and medical activities. Currently, filtration is the most effective process available for removal of fine particles from carrier gases. Purification of gaseous pollutants is associated with adsorption, absorption and incineration. In this paper we discuss a new technique for highly efficient simultaneous purification of gaseous and particulate pollutants from carrier gases, and investigate the utilization of porous media. Our technique involves the passage contaminated carrier gases through a porous medium submerged into a liquid, leading to the formation of narrow and tortuous pathways through the medium. The wet walls of these pathways result in outstanding purification of gaseous, liquid and solid alien additives. NMR imaging was successfully used to map the pathways inside the porous medium submerged into the liquid layer.

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## ***Efficacy of a detector tube method in formaldehyde measurement***

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*Industrial Health 41, 306-12, 2003.*

In order to determine the efficacy of a detector tube method in formaldehyde (HCHO) measurement, we performed a chamber experiment and a field study. The experiment clearly showed that the value obtained by the detector tube method was significantly correlated to that obtained using an active-DNPH method. And was not influenced by the coexistence of toluene, xylene or carbon monoxide, but was by acetaldehyde. In the field study, we investigated 171 rooms in 81 houses. Indoor air was simultaneously sampled for 30 minutes by both an active-DNPH method and the detector tube method. The mean HCHO concentration in the 171 rooms was 0.110±0.089 ppm determined by active-DNPH method and 0.12±0.10 ppm by the detector tube method. Regression analysis showed that the two measures closely correlated with a regression equation  $Y=1.057X+0.002$  ( $r=0.912, p<0.0001$ ), where X is the HCHO concentration determined by the active-DNPH method and Y is that determined by the detector tube method. The mean acetaldehyde concentration in the 171 rooms was 0.024±0.018 ppm using the active-DNPH method. And no correlation was found between acetaldehyde concentrations using the active-DNPH method and the values obtained by the detector tube method. Therefore, this study clearly showed that the detector tube method is not only simple and fast but also precise in measuring HCHO in indoor air.

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## ***Inhalation of 1-bromopropane causes excitation in the central nervous system of male F344 rats.***

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*Neurotoxicology 24(4-5), 563-575, 2003.*

The present study investigates the effects of 1-bromopropane (1BP) on animal behavior to determine the extent of toxicity to the central nervous system (CNS). We measured the spontaneous locomotor activity (SLA) of rats before and after 3 weeks of exposure to 1BP for 8 h per day. In control and 10ppm groups, the SLA values were similar to pre-exposure levels on post-exposure day 1 and thereafter. However, the SLA values in the 50 and 200ppm groups were higher than pre-exposure levels. Open-field behavior was evaluated after exposure, and freezing time decreased with exposure to increasing concentrations of 1BP. Ambulation and rearing scores in the exposed groups were higher than control values, particularly in the 50 and 200ppm groups. The frequency of defecation and urination decreased almost dose-dependently. Exposure 50 to 1,000ppm of 1BP did not affect passive avoidance behavior examined using a step-through type apparatus. The amount of time swimming in the water maze test was not affected in the controls, or groups exposed to 50 and 200ppm 1BP, but that in the 1,000ppm group was increased compared with control. Exposure at 50 to 1,000ppm dose-dependently decreased the traction performance of rats, indicating decreased muscle strength. We found that 10 to 200ppm of 1BP exposure did not affect motor coordination determined by rotor-rod performance. The increased SLA values and open-field activity support the notion that 1BP has excitatory effects on the CNS of F344 male rats. In addition, 1BP reduced the grip or muscle strength of the rats. Memory function was not disordered and the motor coordination of all four limbs remained normal.

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## ***Ultrastructural features of mast cells in picryl chloride (PCL)-induced contact dermatitis in IQI/Jic mice.***

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*Experimental and Toxicologic Pathology.* 54, 265–71, 2003.

Mast cells are one of the major effector cells in the pathogenesis of allergic diseases such as contact dermatitis. In the present study, ultrastructural features of mast cells in contact dermatitis were examined. Namely, the ear of IQI/Jic mice was topically applied with picryl chloride (PCL) at 4 (1st), 11 (2nd), 18 (3rd) and 25 days (4th) after the sensitization with PCL to the abdominal skin. The changes in the ear swelling responses, total serum IgE levels and histology including mast cell numbers were similar to those of previous reports by our research group (Ikeda et al. 2000; Jung et al. 2001). Ultrastructurally, after the 1st application, a close spacial relationship between mast cells and neutrophils and phagocytosis of mast cell granules by neutrophils were observed. Mast cells generally contained non-fused swollen granules filled with altered contents with low electron density and showed an extrusion of membrane-free granules through membrane pores. In addition, interestingly, a few mast cells secreted membrane-bound granules into the dermis without leaving cell membrane damage. After the 4th application when the number of mast cells prominently increased and the total serum IgE level was greatly elevated, in addition to mast cells showing typical anaphylactic degranulation, many mast cells probably in the recovery process from degranulation and several immature mast cells characterized by well-developed Golgi apparatus, many ribosomes and a few electron-dense secretory granules in the peripheral cytoplasm were also observed at the same time. The present results clarified the ultrastructural features of mast cells in the course of PCL-induced contact dermatitis in IQI/Jic mice.

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### ***Increase of olfactory threshold in plating factory workers exposed to chromium in Korea***

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*Industrial Health* 41, 279-285, 2003.

**Objective:** To disclose the effects of chromium (Cr) on olfactory function. **Methods:** Olfactory threshold tests were conducted in 27 male plating workers (Cr workers) with signs and symptoms of olfactory irritation but without nasal septum perforation or ulcer and in 34 male control subjects in Korean plating factories. The Cr workers had been exposed to Cr fume for 0.9 to 18.2 (mean 7.9) years; their blood Cr concentrations (0.16-3.69, mean 1.29 µg/dl) were significantly higher than those in 34 control subjects (0.04-1.95, mean 0.55 µg/dl). **Results:** Scores on recognition thresholds in the Cr workers were significantly higher than those in the control subjects ( $p < 0.05$ ) and positively related significantly to exposure period in 27 Cr workers ( $p < 0.05$ ). Olfactory thresholds were not significantly different between the Cr workers with and without any of nasal signs or symptoms, excepting that the scores on the recognition threshold were significantly higher in those with difficulty in smell ( $p < 0.05$ ). **Conclusion:** It is suggested that olfactory threshold is affected by Cr without development of nasal septum perforation nor ulceration.

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### ***Presence of B7-2+ dendritic cells and expression of Th1 cytokines in the early development of sialodacryoadenitis in the IQI/Jic mouse model of primary Sjogren's syndrome.***

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*Autoimmunity* 36, 247–54, 2003.

Subpopulations of infiltrating lymphocytes, professional antigen-presenting cells (APCs), and Th1/Th2 cytokines that could initiate an autoimmune sialodacryoadenitis were studied in the IQI/Jic mouse model of primary Sjogren's syndrome. Although lymphocytic infiltrations were first seen in submandibular glands (SMGs) of females and in lacrimal glands (LGs) of males at 8 weeks of age, clusters of MHC class II+, CD11c+, B7-2+ dendritic cells (DCs) were already localized in these tissues at 4 weeks. At 8 weeks, the infiltrating lymphocytes consisted of almost equal numbers of B cells and CD4+ T cells. In the inflammatory

foci, MHC class II+, CD11c+, B7-2+ DCs formed network-like structures. Duct cells in the lesions showed immunoreactivities for MHC class II and ALCAM (a costimulatory adhesion molecule). IL-12 and IFN-gamma transcripts were detected by RT-PCR in SMGs of females and in LGs of males at 8-12 weeks. These results suggest that the clustered DCs might play an important role in the initiation of the adenitis, and further suggest that the DCs and epithelial cells may participate in the activation of CD4+ T cells. It is also likely that Th1 cytokines mediate the functional interactions between the APCs and CD4+ T cells in the early lesions.

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### ***Relationship between questionnaire survey results of vibration complaints of wheelchair users and vibration transmissibility of manual wheelchair***

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*Environmental Health and Preventive Medicine 8(3), 82-89, 2003.*

The purpose of this paper is to clarify the relationship between the complaints of wheelchair users and vibration characteristics of the wheelchair, to improve wheelchair comfort and design. From the comparison of the results of questionnaires and the transmissibility measurement of the wheelchair, the resonance frequency-ranges of the maximum vibration transmissibility of the manual wheelchair were consistent with the frequency-ranges of the body parts of the causes of the complaints of wheelchair users. Also, from these experimental results, it was suggested that the improvement point for improving a wheelchair user's comfortableness was to reduce the wheelchair seat vibration transmissibility at around 8 Hz and also was to design wheelchair stiffness and damping characteristics to minimize vibration transmission at the frequencies of the body locations of the causes of the complaints of wheelchair users.

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### ***An investigation of the perception thresholds of band-limited low frequency noises: influence of bandwidth***

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*Journal Low Frequency Noise, Vibration and Active Control 22 (1), 17-25, 2003.*

The perception thresholds of complex low frequency noises have been investigated in a laboratory experiment. The sound pressure levels that were just perceptible by subjects were measured with three random noises and three pure tones. The random noises had a flat constant spectrum over the frequency range 2 to 10, 20, or 40 Hz and decreased with rate of 15 dB per octave at higher frequencies. The frequencies of the pure tones used in this study were 10, 20 and 40 Hz. The perception thresholds were obtained with an all-pass filter, one-third-octave band filters, and the G frequency weighting defined in ISO 7196. The G-weighted sound pressure levels obtained were compared with 100 dB which is described in ISO 7196 as the G-weighted level corresponding to the threshold of sounds in the frequency range 1 to 20 Hz. The perception thresholds of the pure tones measured in this study were comparable to the results available in various literatures. The one-third octave sound pressure levels obtained for the thresholds of the random noises tended to be lower than the measured thresholds of the pure tones. The G-weighted sound pressure levels obtained for the thresholds of the random noises appeared to be lower than 100 dB.

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### ***Determining of crystalline silica in respirable dust samples by infrared spectrophotometry in the presence of interferences***

*Jun Ojima<sup>1</sup>*

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Infrared Spectrophotometry (IR) is now widely used to determine crystalline silica in industrial dust samples. Though the IR method has many advantages when dealing with respirable dust samples, some serious

analytical errors are often caused by interference minerals contamination. These minerals have a characteristic absorption band corresponding in position to the analytical peak for crystalline silica. In this paper, six typical interference minerals (Kaolinite, Mullite, Muscovite, Pyrophyllite, Montmorillonite and Amorphous silica) were pre-size controlled to respirable range and their infrared spectra were measured by means of an FT-IR with the well-known potassium bromide tablet technique. The effects of these interference minerals on the Japanese OEL or the administrative control level for respirable dust which depend on the silica content were calculated and expressed in figures. The measured absorption coefficients of the interference minerals and quartz were 1.36 - 6.98 Abs/mg and 24.46 Abs/mg, respectively. The absorption band height ratios of each interference minerals were also measured. Then the efficiency and applicability of two spectrum correction methods for the interference minerals, absorbance ratio method and difference spectrum method were examined by using artificially mixed samples (standard interference mineral + standard quartz). By comparing the quantifying results for the mixture samples, it was revealed that the interfered spectra were almost corrected successfully when using the difference spectrum method, whereas correction by the absorbance ratio method resulted in apparent negative errors. Furthermore, the difference spectrum method was proven to be superior to the absorbance ratio method in applicability.

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### ***Evaluation of the reverse flow around a worker's body produced by a local exhaust hood***

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*Journal of Occupational Health* 45, 94–103, 2003.

Recent studies have shown that a reverse flow often occurs in a unidirectional airflow in push-pull ventilation and may transport contaminants from the source into a worker's breathing zone. The same problem may arise in local exhaust ventilation when the contaminant source is located in the worker's wake region. In this study, organic solvent work with local exhaust ventilation was duplicated in a laboratory and the details of the reverse flow around the worker's body produced by the ventilation were experimentally investigated. In order to evaluate the influence of the reverse flow on the exposure of the worker, experiments with a mock-up mannequin (dummy worker) and a local ventilation system which was equipped with an exterior type hood and an enclosure type hood were conducted. The exposure level and the contaminant leakage from the hoods in several conditions were measured by means of a smoke test and tracer gas method. Ethanol vapor was used as a tracer gas. With the exterior type hood, the reverse flow visualized by the smoke was observed in front of the standing dummy worker but could not be observed when the dummy worker was seated. From the tracer gas measurements, it was proved that the exposure due to the reverse flow was not so serious at a capture velocity of >0.4 m/s, but <10ppm contaminant leakage from the exterior hood had been recognized independently of the capture velocity. With the enclosure type hood, exposure due to the reverse flow could be controlled with a capture velocity of >0.8m/s. Although the contaminant leakage from the hood due to the reverse flow was not obvious with the enclosure type in any condition, caution should be exercised to prevent exposure when the worker is seated. Regardless of the hood type, the increase in the capture velocity was effective in decreasing exposure due to the reverse flow.

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### ***Assessment of urinary cotinine as a marker of nicotine absorption from tobacco leaves: a study on tobacco farmers in Malaysia***

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*Journal of Occupational Health* 45, 140-145, 2003.

To assess dermal absorption of nicotine from tobacco leaves in relation to Green Tobacco Sickness (GTS), urinary cotinine concentrations were measured in 80 male tobacco-growing farmers and in 40 healthy males (controls) who did not handle wet tobacco leaves in Kelantan, Malaysia. Among non-smokers, urinary cotinine levels in farmers were significantly higher than those of controls; farmers with urinary cotinine of 50ng/ml/m<sup>2</sup> or above showed eye symptoms more frequently than those below this level (p<0.05). Farmers who did not wear protective equipment had subjective symptoms more frequently than those who used the equipment

( $p < 0.05$ ); some of these symptoms were seen more frequently in organophosphate (Tamaron) users than in non-users. As tobacco farmers evidence a risk of nicotine poisoning from tobacco leaves, assessment including GTS together with effects of pesticides will be necessary.

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### ***Thorium-232 exposure during tungsten inert gas arc welding and electrode sharpening***

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*Industrial Health 41, 273–278, 2003.*

To assess the exposure of welders to thorium-232 (<sup>232</sup>Th) during tungsten inert gas arc (TIG) welding, airborne concentrations of <sup>232</sup>Th in the breathing zone of welder and background levels were measured. The radioactive concentrations were  $1.11 \times 10^{-2}$  Bq/m<sup>3</sup> during TIG welding of aluminum (TIG/Al),  $1.78 \times 10^{-4}$  Bq/m<sup>3</sup> during TIG welding of stainless steel (TIG/SS), and  $1.93 \times 10^{-1}$  Bq/m<sup>3</sup> during electrode sharpening, with  $5.82 \times 10^{-5}$  Bq/m<sup>3</sup> background concentration. Although the annual intake of <sup>232</sup>Th estimated using these values was found not to exceed the annual limit intake (ALI,  $1.6 \times 10^2$  Bq) using a dust respirator, it is recommended that <sup>232</sup>Th exposure be reduced by substituting the thoriated electrode with a thorium-free electrode, setting up a local ventilation system, and by using protective respiratory equipment. It is also necessary to inform workers that thoriated tungsten electrodes contain radioactive material.

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### ***Musculoskeletal disorders among female Australian nurses working in a unique tropical environment: results from a pilot study***

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*Ergonomics Australian 17, 14-17, 2003.*

We investigated the prevalence of Musculoskeletal Disorders (MSD) among Australian nurses using a previously validated, self-reporting questionnaire. From a total group of 148 females, 92.6% reported an MSD of some description occurring within the previous 12-month period. Lower back was the most commonly reported body site (74.3%), followed by the neck (58.1%), shoulders (43.2%) and upper back (31.1%). Tobacco smoking was correlated with MSD as follows: lower arm MSD (OR 8.6, 95%CI 1.6-64.7,  $P = 0.0187$ ), lower back MSD (OR 3.4, 95%CI 1.1-12.8,  $P = 0.0470$ ) and wrist MSD (OR 3.2, 95%CI 1.1-9.3,  $P = 0.0292$ ). Alcohol consumption was also correlated with MSD at the following body sites: upper arm MSD (OR 3.5, 95%CI 1.1-13.8,  $P = 0.0455$ ), MSD of the upper legs (OR 3.3, 95%CI 1.4-9.2,  $P = 0.0124$ ) and MSD of the upper back (OR 2.4, 95%CI 1.1-6.0,  $P = 0.0442$ ). Overall, this pilot study suggests that Australian nurses working in a tropical environment may report MSD at rates higher than their counterparts in other countries. Further research of a larger scale is necessary to determine the true nature of MSD among this unique occupational group.

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### ***Experimental model to study reproductive toxicity of chemicals using induced ovulation in immature F344 rats.***

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*Industrial Health 41, 287-290, 2003.*

Forced ovulation induced by the administration of exogenous gonadotropin is a useful marker to study the ovarian toxicity of chemicals in experimental animals. We examined the toxicity of di-(2-ethylhexyl) phthalate

(DEHP) in the ovaries of immature F344 female rats. Superovulation was induced by injections of equine chorionic gonadotropin (eCG) and human chorionic gonadotropin (hCG) in rats dosed with 125, 250, 500, 1,000 or 2,000 mg/kg body weight of DEHP for consecutive 4 days. However, the number of ova shed during superovulation significantly decreased in rats treated with DEHP at 500 mg/kg as compared with control, but no changes were observed in the number of ova in groups given other doses of DEHP. In control rats treated with olive oil, hypophysectomy reduced significantly the number of ovulated ova. When 2,000 mg DEHP was given to hypophysectomized (hypox) rats, the number of ova in the hypox group was significantly smaller than that in the intact group administered with the same doses of DEHP. In contrast, the numbers of ova of intact and hypox groups did not significantly differ in rats given 500 mg DEHP. The levels of circulating thyroxine (T<sub>4</sub>) were significantly decreased by 2000 mg DEHP in intact rats, and the tendency of decrease in T<sub>4</sub> by 2,000 mg DEHP was also observed in hypox rats. These results suggest that daily administration of 500 mg DEHP suppressed superovulation in immature F344 rats by disrupting the hypothalamic-pituitary-ovarian axis in a manner similar to that of hypophysectomy. Decreased circulating T<sub>4</sub> levels seemed to abrogate this disruption as observed in recovered superovulation after treatment with 2,000 mg DEHP.

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## ***The role of prescribed napping in sleep medicine***

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*Sleep Medicine Reviews* 7, 227-235, 2003.

Napping, when its timing and duration are designed properly, has the potential to improve our daily lives. Laboratory findings indicate that scheduled napping promotes waking function after normal sleep at night, and also counteracts decreased alertness and performance under conditions of sleep deprivation. Since these effects are evident even with naps shorter than 30 min, shift work problems may be alleviated by the short nap at the workplace. Multiple short naps are effective in managing excessive daytime sleepiness in narcoleptic patients under medication. The therapeutic usefulness of napping in other sleep disorders, however, remains to be established. Epidemiological studies suggest a decrease in the risk of cardiovascular and cognitive dysfunction by the practice of taking short naps several times a week. Sleep inertia occurs immediately after napping, but its severity can be minimized by avoiding long naps that may result in awakening from deep non-rapid eye movement sleep. Activities during the post-nap period should also be undertaken carefully. To allow the maximum advantage to be gained from napping, more efforts are needed to identify the strategies of napping that are compatible with individual cases including aging, work schedules, and sleep disorders, and to examine their efficacy in real-life settings.

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## ***Imbalance of testosterone level in male offspring rats perinatally exposed to bisphenol A***

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*Industrial Health* 41, 338-341, 2003.

The purpose of this study was to investigate whether exposure to bisphenol A (BPA) through placenta and milk has any effect on reproductive system in male offspring. Pregnant rats were treated with BPA at 0, 4, 40, and 400 mg/kg body weight, from gestation day 6 through lactation day 20 by gavage. Plasma testosterone concentrations in offspring at 9-week old were significantly elevated in BPA groups as compared with those of control. At the age of 36 weeks the hormone concentrations showed an increase in a dose-dependent manner, although without statistical significance. Testosterone contents in testes showed a similar tendency to that in plasma, though being statistically insignificant. Little alteration in testes weight was showed in BPA-exposed offspring. There was no remarkable change in plasma concentrations of luteinizing hormone and follicle-stimulating hormone at 9-week old. The pathway of E2 (17 $\beta$ -estradiol) formation from testosterone seemed not to be affected by BPA. The results indicate that exposure to BPA during perinatal period has a significant effect on the testosterone homeostasis in male offspring of rats.

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## ***Effect of ultraviolet irradiation on the protein synthesis of human skin cells: a study with a monochromatic ultraviolet irradiation apparatus***

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Human beings always suffer from serious risk of exposure to ultraviolet (UV) rays in general as well as in work environments but the health effects of UV are not yet fully understood. To enable fine analysis of the biological effects of UV at any given wavelength, we developed an apparatus that can experimentally irradiate cultured mammalian cells with monochromatic UV rays at any given wavelength. With this device, the effects of UV at 260, 280, 300 and 320 nm on the total protein synthesis of human skin-derived NB1RGB cells were examined. An inhibitory effect of UV at 260 and 280 nm was evident, UV at 300 and 320 nm had only a marginal effect. UV at 280 nm was also decreased amino acid uptake, which appears at least partly, to be responsible for reduced protein synthesis. Metallothioneins (MTs), known as proteins defending against heavy metal toxicity, have been reported to be induced after UV irradiation, but UV at 280 nm did not induce MTs in NB1RGB cells. Cadmium pretreatment of cells, that had been assumed to protect cells from UV damage via MT induction, did not increase cell viability after exposure to UV at 280 nm. The present study unambiguously revealed the biological effects of monochromatic UV rays, also showing that UV-irradiating apparatus can be a powerful tool for studying the health effects of UV.

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## ***Associations between oxidative stress levels and total duration of engagement in jobs with exposure to fly ash among workers at municipal solid waste incinerators***

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The fly ash from municipal solid waste incinerators (MSWIs) is known to contain heavy metals, polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polyaromatic hydrocarbons (PAHs), and other organic materials. Heavy metals, PCDDs, PCDFs, and PAHs reportedly cause oxidative stress in vitro and in vivo. In this study, we measured the blood and urinary levels of several oxidative stress markers in MSWI workers, and discuss herein whether the duration of engagement in jobs with exposure to MSWI fly ash is associated with these levels. The subjects were 81 male workers (mean age 42.7) from four MSWIs in the same city. Job history was interviewed from each subject and jobs were categorized according to the possibilities of exposure to fly ash. The subjects were classified into four groups; long duration of engagement in jobs with exposure to fly ash, short duration of engagement in jobs with exposure to fly ash, engagement in jobs with limited exposure to fly ash, and control. Blood and urine specimens were obtained from the subjects in the morning before breakfast. The levels of 8-hydroxy-2'-deoxyguanosine in the urine and leukocytes were measured as markers of oxidative DNA damage. Blood malondialdehyde and lipid peroxide levels, and total urinary biopyrrins level were also measured as markers of systemic oxidative stress. The mean levels of all markers were compared among the four groups. There was a significant trend showing that the level of urinary 8-OH-dG rose with increased duration of engagement in jobs with exposure to MSWI fly ash ( $P < 0.05$ ). Considering this result, we speculated that certain chemicals in fly ash might have induced oxidative stress in the study subjects.

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## ***Development and evaluation of a new push-pull ventilation system for sheet-adhesive work inside bus-body***

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We present the performance of a new push-pull ventilation system for sheet-adhesive work inside the body of a sightseeing coach. The target sightseeing coach was 12 m long, 2.5 m wide and 2 m high from floor to ceiling. We made a prototype of an airflow system and a half-scale model of the bus-body. The half scale model was 6

m long, 1.25 m wide and 0.965 m high. The push-pull ventilation system and half-scale model were used to evaluate the flow distributions inside the model. We also measured the concentration of xylene and methanol vapors during simulated sheet-adhesive work. As a result, it was found that the best combination was a push flow of 24 m<sup>3</sup>/min and a pull flow of 78 m<sup>3</sup>/min in this model, and the flow velocity in the model was less than 1 m/s. This system is potentially applicable to any interior work for not only bus-bodies but also train and airplane bodies, which have elongated and confined space with many openings.

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