

5. References

- Abbracchio, M.P., Heck, J.D., Caprioli, R.M. & Costa, M. (1981) Differences in surface properties of amorphous and crystalline metal sulfides may explain their toxicological potency. *Chemosphere*, 10, 897-908
- Abbracchio, M.P., Simmons-Hansen, J. & Costa, M. (1982a) Cytoplasmic dissolution of phagocytized crystalline nickel sulfide particles: a prerequisite for nuclear uptake of nickel. *J. Toxicol. environ. Health*, 9, 663-676
- Abbracchio, M.P., Heck, J.D. & Costa, M. (1982b) The phagocytosis and transforming activity of crystalline metal sulfide particles are related to their negative surface charge. *Carcinogenesis*, 3, 175-180
- Acheson, E.D., Cowdell, R.H. & Rang, E.H. (1981) Nasal cancer in England and Wales: an occupational survey. *Br. J. ind. Med.*, 38, 218-224
- Adalis, D., Gardner, D.E. & Miller, F.J. (1978) Cytotoxic effects of nickel on ciliated epithelium. *Am. Rev. respir. Dis.*, 118, 347-354
- Adams, D.B. (1980) The routine determination of nickel creatinine in urine. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, London, Academic Press, pp. 99-102
- Adamsson, E., Lind, B., Nielsen, B. & Piscator, M. (1980) Urinary and fecal elimination of nickel in relation to airborne nickel in a battery factory. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, London, Academic Press, pp. 103-106
- Aitio, A. (1984) Biological monitoring of occupational exposure to nickel. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 497-505
- Aitio, A., Tossavainen, A., Gustafsson, T., Kiilunen, M., Haapa, K. & Järvisalo, J. (1985) Urinary excretion of nickel and chromium in workers of a steel foundry. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publishers, pp. 149-152

- Albert, D.M., Gonder, J.R., Papale, J., Craft, J.L., Dohlman, H.G., Reid, M.C. & Sunderman, F.W., Jr (1980) Induction of ocular neoplasms in Fischer rats by intraocular injection of nickel subsulfide. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, London, Academic Press, pp. 55-58
- Aldrich Chemical Co., Inc. (1988) *Aldrich Catalog/Handbook of Fine Chemicals*, Milwaukee, WI, pp. 1097-1099
- Alexander, A.J., Goggin, P.L. & Cooke, M. (1983) A Fourier-transform infrared spectrometric study of the pyrosynthesis of nickel tetracarbonyl and iron pentacarbonyl by combustion of tobacco. *Anal. chim. Acta*, 151, 1-12
- Amacher, D.E. & Paillet, S.C. (1980) Induction of trifluorothymidine-resistant mutants by metal ions in L5178Y/TK⁺ cells. *Mutat. Res.*, 78, 279-288
- Amavis, R., Hunter, W.J. & Smeets, J.G.P.M., eds (1976) *Hardness of Drinking Water and Public Health. Proceedings of the European Scientific Colloquium, Luxembourg, May 1975* (EUR 5447), Oxford, Pergamon Press, p. 194
- American Conference of Governmental Industrial Hygienists (1988) *Threshold Limit Values and Biological Exposure Indices for 1988-1989*, Cincinnati, OH, p. 28
- American Tokyo Kasei (1988) *Organic Chemicals 88/89 Catalog*, Portland, OR, p. 913
- Amlacher, E. & Rudolph, C. (1981) The thymidine incorporation inhibiting screening system (TSS) to test carcinogenic substances: a nuclear DNA synthesis suppressive short term test. *Arch. Geschwulstforsch.*, 51, 605-610
- Andersen, O. (1983) Effects of coal combustion products and metal compounds on sister chromatid exchange (SCE) in a macrophage-like cell line. *Environ. Health Perspect.*, 47, 239-253
- Andersen, O. (1985) Evaluation of the spindle-inhibiting effect of Ni⁺⁺ by quantitation of chromosomal super-contraction. *Res. Commun. chem. Pathol. Pharmacol.*, 50, 379-386
- Andersen, I. & Svenes, K.B. (1989) Determination of nickel in lung specimens of thirty-nine autopsied nickel workers. *Int. Arch. occup. environ. Health*, 61, 289-295
- Andersen, J.R., Gammelgaard, B. & Reimert, S. (1986) Direct determination of nickel in human plasma by Zeeman-corrected atomic absorption spectrometry. *Analyst*, 3, 721-722
- Andersson, K., Elinder, C.G., Høgstvedt, C., Kjellström, T. & Spång, G. (1984) Mortality among cadmium and nickel-exposed workers in a Swedish battery factory. *Toxicol. environ. Chem.*, 9, 53-62
- Angerer, J. & Heinrich-Ramm, R. (1988) Nickel in blood (Ger.). In: *Analytische Methoden zur Prüfung gesundheitsschädlicher Arbeitsstoffe — Analysen in biologischem Material* (Analytical Methods for Investigation of Noxious Occupational Substances. Analysis in Biological Material), Vol. 2/3, Part 9, Weinheim, VCH-Verlagsgesellschaft, pp. 1-11
- Angerer, J. & Schaller, K.H. (1985) *Analyses of Hazardous Substances in Biological Materials*, Vol. 1, Weinheim, VCH-Verlagsgesellschaft, pp. 177-188

- Angerer, J., Heinrich-Ramm, R. & Lehnert, G. (1989) Occupational exposure to cobalt and nickel. Biological monitoring. *Int. J. environ. anal. Chem.*, 35, 81-88
- Antonsen, D.H. (1981) Nickel compounds. In: Mark, H.F., Othmer, D.F., Overberger, C.G., Seaborg, G.T. & Grayson, M., eds, *Kirk-Othmer Encyclopedia of Chemical Technology*, 3rd ed., Vol. 15, New York, John Wiley & Sons, pp. 801-819
- Anwer, J. & Mehrotra, N.K. (1986) Effect of simultaneous exposure to nickel chloride and benzo(a)pyrene on developing chick embryos. *Drug chem. Toxicol.*, 9, 171-183
- Arbeidsinspectie (Labour Inspection) (1986) *De Nationale MAC-Lijst 1986* (National MAC-List 1986), Voorburg, p. 18
- Arbejdstilsynet (Labour Inspection) (1988) *Graensevaerdier for Stoffer og Materialer* (Limit Values for Compounds and Materials) (No. 3.1.0.2), Copenhagen, p. 25
- Arbetskyddsstyrelsens (National Board of Occupational Safety and Health) (1987) *Hygieniska Gränsvärden* (Hygienic Limit Values), Stockholm, p. 35
- Archer, F.C. (1980) Trace elements in soils in England and Wales. In: *Inorganic Pollution and Agriculture*, London, Her Majesty's Stationery Office, pp. 184-190
- Arlauskas, A., Baker, R.S.U., Bonin, A.M., Tandon, R.K., Crisp, P.T. & Ellis, J. (1985) Mutagenicity of metal ions in bacteria. *Environ. Res.*, 36, 379-388
- Barton, R.T., Andersen, I. & Høgetveit, A.C. (1980) Distribution of nickel in blood fractions. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, London, Academic Press, pp. 85-88
- Basrur, P.K. & Gilman, J.P.W. (1967) Morphologic and synthetic response of normal and tumor muscle cultures to nickel sulfide. *Cancer Res.*, 27, 1168-1177
- Beach, D.J. & Sunderman, F.W., Jr (1969) Nickel carbonyl inhibition of ¹⁴C-orotic acid incorporation into rat liver RNA. *Proc. Soc. exp. Biol. Med.*, 131, 321-322
- Beach, D.J. & Sunderman, F.W., Jr (1970) Nickel carbonyl inhibition of RNA synthesis by a chromatin-RNA polymerase complex from hepatic nuclei. *Cancer Res.*, 30, 48-50
- Bencko, V. (1983) Nickel: a review of its occupational and environmental toxicology. *J. Hyg. Epidemiol. Microbiol. Immunol.*, 27, 237-247
- Bennett, B.G. (1984) Environmental nickel pathways to man. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 487-495
- Benson, J.M., Henderson, R.F., McClellan, R.O. & Rebar, A.H. (1985) Comparative toxicity of nickel salts to the lung. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publications, pp. 85-88
- Benson, J.M., Henderson, R.F. & McClellan, R.O. (1986a) Comparative cytotoxicity of four nickel compounds to canine and rodent alveolar macrophages *in vitro*. *J. Toxicol. environ. Health*, 19, 105-110
- Benson, J.M., Henderson, R.F., McClellan, R.O., Hanson, R.L. & Rebar, A.H. (1986b) Comparative acute toxicity of four nickel compounds to F344 rat lung. *Fundam. appl. Toxicol.*, 7, 340-347
- Benson, J.M., Carpenter, R.L., Hahn, F.F., Haley, P.J., Hanson, R.L., Hobbs, C.H., Pickrell, J.A. & Dunnick, J.K. (1987) Comparative inhalation toxicity of nickel subsulfide to F344/N rats and B6C3F₁ mice exposed for 12 days. *Fundam. appl. Toxicol.*, 9, 251-265

- Benson, J.M., Henderson, R.F. & Pickrell, J.A. (1988a) Comparative in vitro cytotoxicity of nickel oxides and nickel-copper oxides to rat, mouse, and dog pulmonary alveolar macrophages. *J. Toxicol. environ. Health*, 24, 373-383
- Benson, J.M., Burt, D.G., Carpenter, R.L., Eidson, A.F., Hahn, F.F., Haley, P.J., Hanson, R.L., Hobbs, C.H., Pickrell, J.A. & Dunnick, J.K. (1988b) Comparative inhalation toxicity of nickel sulfate to F344/N rats and B6C3F₁ mice exposed for 12 days. *Fundam. appl. Toxicol.*, 10, 164-178
- Bergman, B., Bergman, M., Magnusson, B., Söremark, R. & Toda, Y. (1980) The distribution of nickel in mice. An autoradiographic study. *J. oral Rehabil.*, 7, 319-324
- Bernacki, E.J., Parsons, G.E., Roy, B.R., Mikac-Devic, M., Kennedy, C.D. & Sunderman, F.W., Jr (1978a) Urine nickel concentrations in nickel-exposed workers. *Ann. clin. Lab. Sci.*, 8, 184-189
- Bernacki, E.J., Parsons, G.E. & Sunderman, F.W., Jr (1978b) Investigation of exposure to nickel and lung cancer mortality. Case control study at a aircraft engine factory. *Ann. clin. Lab. Sci.*, 8, 190-194
- Bernacki, E.J., Zygowicz, E. & Sunderman, F.W., Jr (1980) Fluctuations of nickel concentrations in urine of electroplating workers. *Ann. clin. Lab. Sci.*, 10, 33-39
- Berry, J.P., Galle, P., Poupon, M.F., Pot-Deprun, J., Chouroulinkov, I., Judde, J.G. & Dewally, D. (1984) Electron microprobe in vitro study of interaction of carcinogenic nickel compounds with tumour cells. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 153-164
- Biedermann, K.A. & Landolph, J.R. (1987) Induction of anchorage independence in human diploid foreskin fibroblasts by carcinogenic metal salts. *Cancer Res.*, 47, 3815-3823
- Biggart, N.W. & Costa, M. (1986) Assessment of the uptake and mutagenicity of nickel chloride in *Salmonella* tester strains. *Mutat. Res.*, 175, 209-215
- Biggart, N.W. & Murphy, E.C., Jr (1988) Analysis of metal-induced mutations altering the expression or structure of a retroviral gene in a mammalian cell line. *Mutat. Res.*, 198, 115-129
- Blakeley, St J.H. & Zatka, V.J. (1985) *Report to the NiPERA Scientific Advisory Committee on Interlaboratory Test Program on Nickel Phase Speciation in Dust Samples. First Test on Bulk Dust Samples — Summer 1985*, Toronto, Nickel Producers Environmental Research Association
- Boldt, J. & Queneau, P. (1967) *The Winning of Nickel*, New York, Van Nostrand
- Bonde, I., Beck, H.-I., Jørgensen, P.J. & Grandjean, P. (1987) Nickel levels in intercellular fluid from nickel-allergic patients and controls. In: *Trace Elements in Human Health and Disease, Abstracts, Second Nordic Symposium, August 1987*, Odense, University of Copenhagen, Copenhagen, World Health Organization, p. D12
- Bossu, F.P., Paniago, E.B., Margerum, D.W., Kirksey, S.T., Jr & Kurtz, J.L. (1978) Trivalent nickel catalysis of the autooxidation of nickel(II) tetraglycine. *Inorg. Chem.*, 17, 1034-1042
- Boysen, M., Solberg, L.A., Torjussen, W., Poppe, S. & Høgetveit, A.C. (1984) Histological changes, rhinoscopic findings and nickel concentration in plasma and urine in retired nickel workers. *Acta otolaryngol.*, 97, 105-115

- Bridge, J.C. (1933) *Annual Report of the Chief Inspector of Factories and Workshops for the Year 1932*, London, His Majesty's Stationery Office, pp. 103-109
- Brinton, L.A., Blot, W.J., Becker, J.A., Winn, D.M., Browder, J.P., Farmer, J.C., Jr & Fraumeni, J.F., Jr (1984) A case-control study of cancers of the nasal cavity and paranasal sinuses. *Am. J. Epidemiol.*, *119*, 896-906
- Brown, S.S., Nomoto, S., Stoeppler, M. & Sunderman, F.W., Jr (1981) IUPAC reference method for analysis of nickel in serum and urine by electrothermal atomic absorption spectrometry. *Clin. Biochem.*, *14*, 295-299
- Burges, D.C.L. (1980) Mortality study of nickel platers In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, London, Academic Press, pp. 15-18
- Burgess, W.A. (1981) *Recognition of Health Hazards in Industry. A Review of Materials and Processes*, New York, John Wiley & Sons
- Buselmaier, M., Röhrborn, G. & Propping, P. (1972) Mutagenicity testing with pesticides in the host-mediated assay and in the dominant lethal test in mouse (Ger.). *Biol. Zbl.*, *91*, 311-325
- Callan, W.M. & Sunderman, F.W., Jr (1973) Species variations in binding of $^{63}\text{Ni}(\text{II})$ by serum albumin. *Res. Commun. chem. Pathol. Pharmacol.*, *5*, 459-472
- Camner, P., Johansson, A. & Lundborg, M. (1978) Alveolar macrophages in rabbits exposed to nickel dust. Ultrastructural changes and effect on phagocytosis. *Environ. Res.*, *16*, 226-235
- Camner, P., Casarett-Bruce, M., Curstedt, T., Jarstrand, C., Wiernik, A., Johansson, A., Lundborg, M. & Robertson, B. (1984) Toxicology of nickel. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 267-276
- Camner, P., Curstedt, T., Jarstrand, C., Johansson, A., Robertson, B. & Wiernik, A. (1985) Rabbit lung after inhalation of manganese chloride: a comparison with the effects of chlorides of nickel, cadmium, cobalt, and copper. *Environ. Res.*, *38*, 301-309
- Carvalho, S.M.M. & Ziemer, P.L. (1982) Distribution and clearance of ^{63}Ni administered as $^{63}\text{NiCl}_2$ in the rat: intratracheal study. *Arch. environ. Contam. Toxicol.*, *11*, 245-248
- Casey, C.E. & Robinson, M.F. (1978) Copper, manganese, zinc, nickel, cadmium and lead in human foetal tissues. *Br. J. Nutr.*, *39*, 639-646
- Catalanatto, F.A. & Sunderman, F.W., Jr (1977) Nickel concentrations in human parotid saliva. *Ann. clin. Lab. Sci.*, *7*, 146-151
- Cawse, P.A. (1978) *A Survey of Atmospheric Trace Elements in the UK: Results for 1977* (Harwell Report AERE-R 9164), Harwell, Environmental and Medical Sciences Division, Atomic Energy Authority
- Chamberlain, P.G. (1988) Nickel. In: *Minerals Yearbook 1986* (Preprint from Bulletin 675), Vol. I, *Metals and Minerals*, Washington DC, Bureau of Mines, US Government Printing Office, pp. 1-17
- Chemical Information Services Ltd (1988) *Directory of World Chemical Producers 1989/90 Edition*, Oceanside, NY, pp. 49, 287, 426-427, 489-490
- Chmielnicka, J., Szymanska, J.A. & Tyfa, J. (1982) Disturbances in the metabolism of endogenous metals (Zn and Cu) in nickel-exposed rats. *Environ. Res.*, *27*, 216-221

- Chorvatovičová, D. (1983) The effect of NiCl₂ on the level of chromosome aberrations in Chinese hamster *Cricetulus griseus* (Czech.). *Biológia (Bratislava)*, 38, 1107-1112
- Chovil, A., Sutherland, R.B. & Halliday, M. (1981) Respiratory cancer in a cohort of nickel sinter plant workers. *Br. J. ind. Med.*, 38, 327-333
- Christensen, O.B. & Lagesson, V. (1981) Nickel concentration of blood and urine after oral administration. *Ann. clin. Lab. Sci.*, 11, 119-125
- Christensen, O.B. & Möller, H. (1978) Release of nickel from cooking utensils. *Contact Dermatitis*, 4, 343-346
- Christensen, O.B., Möller, H., Andrasko, L. & Lagesson, V. (1979) Nickel concentration of blood, urine and sweat after oral administration. *Contact Dermatitis*, 5, 312-316
- Christie, N.T. & Costa, M. (1984) In vitro assessment of the toxicity of metal compounds. IV. Disposition of metals in cells: interactions with membranes, glutathione, metallothionein, and DNA. *Biol. Trace Elem. Res.*, 6, 139-158
- Christie, N.T., Tummolo, D.M., Biggart, N.W. & Murphy, E.C., Jr (1988) Chromosomal changes in cell lines from mouse tumors induced by nickel sulfide and methylcholanthrene. *Cell Biol. Toxicol.*, 4, 427-445
- Christie, N.T., Tummolo, D.M., Klein, C.B. & Rossman, T.G. (1990) The role of Ni(II) in mutation. In: Nieboer, E. & Aitio, A., eds, *Advances in Environmental Science and Technology, Nickel and Human Health: Current Perspectives*, New York, John Wiley & Sons (in press)
- Ciccarelli, R.B. & Wetterhahn, K.E. (1982) Nickel distribution and DNA lesions induced in rat tissues by the carcinogen nickel carbonate. *Cancer Res.*, 42, 3544-3549
- Ciccarelli, R.B. & Wetterhahn, K.E. (1984a) Molecular basis for the activity of nickel. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 201-213
- Ciccarelli, R.B. & Wetterhahn, K.E. (1984b) Nickel-bound chromatin, nucleic acids, and nuclear proteins from kidney and liver of rats treated with nickel carbonate *in vivo*. *Cancer Res.*, 44, 3892-3897
- Ciccarelli, R.B. & Wetterhahn, K.E. (1985) In vitro interaction of 63-nickel(II) with chromatin and DNA from rat kidney and liver nuclei. *Chem.-biol. Interact.*, 52, 347-360
- Ciccarelli, R.B., Hampton, T.H. & Jennette, K.W. (1981) Nickel carbonate induces DNA-protein crosslinks and DNA strand breaks in rat kidney. *Cancer Lett.*, 12, 349-354
- Cirla, A.M., Bernabeo, F., Ottoboni, F. & Ratti, R. (1985) Nickel induced occupational asthma: immunological and clinical aspects. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publications, pp. 165-168
- Considine, D.M., ed. (1974) *Chemical and Process Technology Encyclopedia*, New York, McGraw Hill Book, pp. 394, 613, 765-769
- Cook, W.A. (1987) *Occupational Exposure Limits — Worldwide*, Washington DC, American Industrial Hygiene Association, pp. 124, 147, 203
- Corbett, T.H., Heidelberger, C. & Dove, W.F. (1970) Determination of the mutagenic activity to bacteriophage T4 of carcinogenic and noncarcinogenic compounds. *Mol. Pharmacol.*, 6, 667-679

- Cornell, R.G. (1984) Mortality patterns among stainless-steel workers. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 65-71
- Cornell, R.G. & Landis, J.R. (1984) Mortality patterns among nickel/chromium alloy foundry workers. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 87-93
- Costa, M. (1980) Biochemical and morphological transformation of hamster embryo cells in tissue culture by specific metal compounds. In: Bhatnagar, R.E., ed., *Molecular Basis of Environmental Toxicity*, Ann Arbor, MI, Ann Arbor Science Publishers, pp. 373-389
- Costa, M. (1983) Sequential events in the induction of transformation in cell culture by specific nickel compounds. *Biol. Trace Elem. Res.*, 5, 285-295
- Costa, M. & Heck, J.D. (1984) Perspectives on the mechanism of nickel carcinogenesis. In: Eichhorn, G.L. & Marzilli, L., eds, *Advances in Organic Biochemistry*, Vol. 6, Berlin (West), Springer-Verlag, pp. 285-309
- Costa, M. & Heck, J.D. (1986) Metal ion carcinogenesis: mechanistic aspects. In: Sigel, H., ed., *Metal Ions in Biological Systems*, Vol. 20, *Concepts on Metal Ion Toxicity*, New York, Marcel Dekker, pp. 259-278
- Costa, M. & Mollenhauer, H.H. (1980a) Carcinogenic activity of particulate nickel compounds is proportional to their cellular uptake. *Science*, 209, 515-517
- Costa, M. & Mollenhauer, H.H. (1980b) Phagocytosis of nickel subsulfide particles during the early stages of neoplastic transformation in tissue culture. *Cancer Res.*, 40, 2688-2694
- Costa, M. & Mollenhauer, H.H. (1980c) Phagocytosis of particulate nickel compounds is related to their carcinogenic activity. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, New York, Academic Press, pp. 43-46
- Costa, M., Nye, J.S., Sunderman, F.W., Jr, Allpass, P.R. & Gondos, B. (1979) Induction of sarcomas in nude mice by implantation of Syrian hamster fetal cells exposed *in vitro* to nickel subsulfide. *Cancer Res.*, 39, 3591-3597
- Costa, M., Jones, M.K. & Lindberg, O. (1980) Metal carcinogenesis in tissue culture systems. In: Martell, A.E., ed., *Inorganic Chemistry in Biology and Medicine* (ACS Symposium Series No. 140), Washington DC, American Chemical Society, pp. 45-73
- Costa, M., Simmons-Hansen, J., Bedrossian, C.W.M., Bonura, J. & Caprioli, R.M. (1981a) Phagocytosis, cellular distribution, and carcinogenic activity of particulate nickel compounds in tissue culture. *Cancer Res.*, 41, 2868-2876
- Costa, M., Abbraccio, M.P. & Simmons-Hansen, J. (1981b) Factors influencing the phagocytosis, neoplastic transformation, and cytotoxicity of particulate nickel compounds in tissue culture systems. *Toxicol. appl. Pharmacol.*, 60, 313-323
- Costa, M., Heck, J.D. & Robison, S.H. (1982) Selective phagocytosis of crystalline metal sulfide particles and DNA strand breaks as a mechanism for the induction of cellular transformation. *Cancer Res.*, 42, 2757-2763
- Cotton, F.A. & Wilkinson, G. (1988) *Advanced Inorganic Chemistry*, 5th ed., New York, John Wiley & Sons, pp. 741-755

- Cox, J.E., Doll, R., Scott, W.A. & Smith, S. (1981) Mortality of nickel workers: experience of men working with metallic nickel. *Br. J. ind. Med.*, 38, 235-239
- Cragle, D.L., Hollis, D.R., Newport, T.H. & Shy, C.M. (1984) A retrospective cohort mortality study among workers occupationally exposed to metallic nickel powder at the Oak Ridge gaseous diffusion plant. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 57-63
- Cronin, E., Di Michiel, A.D. & Brown, S.S. (1980) Oral challenge in nickel-sensitive women with hand eczema. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, London, Academic Press, pp. 149-152
- Cuckle, H., Doll, R. & Morgan, L.G. (1980) Mortality study of men working with soluble nickel compounds. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, London, Academic Press, pp. 11-14
- Daldrup, T., Haarhoff, K. & Szathmary, S.C. (1983) Fetal nickel sulfate intoxication (Ger.). *Beitr. gerichtl. Med.*, 41, 141-144
- Damjanov, I., Sunderman, F.W., Jr, Mitchell, J.M. & Allpass, P.R. (1978) Induction of testicular sarcomas in Fischer rats by intratesticular injection of nickel subsulfide. *Cancer Res.*, 38, 268-276
- Daniel, M.R. (1966) Strain differences in the response of rats to the injection of nickel sulphide. *Br. J. Cancer.*, 20, 886-895
- Daniel, M., Edwards, M. & Webb, M. (1974) The effect of metal-serum complexes on differentiating muscle *in vitro*. *Br. J. exp. Pathol.*, 55, 237-244
- Decheng, C., Ming, J., Ling, H., Shan, W., Ziqing, Z. & Xinchui, Z. (1987) Cytogenetic analysis in workers occupationally exposed to nickel carbonyl. *Mutat. Res.*, 188, 149-152
- De Flora, S., Zanicchi, P., Camoirano, A., Bennicelli, C. & Badolati, G.S. (1984) Genotoxic activity and potency of 135 compounds in the Ames reversion test and in a bacterial DNA-repair test. *Mutat. Res.*, 133, 161-198
- Deknudt, G. & Léonard, A. (1982) Mutagenicity tests with nickel salts in the male mouse. *Toxicology*, 25, 289-292
- Deng, C. & Ou, B. (1981) The cytogenetic effects of nickel sulphate (Chin.). *Acta genet. sin.*, 8, 212-215
- Deng, C.Z., Ou, B., Huang, J., Zhuo, Z., Xian, H., Yao, M.C., Chen, M.Y., Li, Z.X., Sheng, S.Y. & Yei, Z.F. (1983) Cytogenetic effects of electroplating workers (Chin.). *Acta sci. circumst.*, 3, 267-271
- Deng, C.Z., Lee, H.C.H., Xian, H.L., Yao, M.C., Huang, J.C. & Ou, B.X. (1988) Chromosomal aberrations and sister chromatid exchanges of peripheral blood lymphocytes in Chinese electroplating workers: effect of nickel and chromium. *J. trace Elements exp. Med.*, 1, 57-62
- Dewally, D. & Hildebrand, H.F. (1980) The fate of nickel subsulphide implants during carcinogenesis. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, London, Academic Press, pp. 51-54
- DiPaolo, J.A. & Casto, B.C. (1979) Quantitative studies of *in vivo* morphological transformation of Syrian hamster cells by inorganic metal salts. *Cancer Res.*, 39, 1008-1013
- Doll, R. (1958) Cancer of the lung and nose in nickel workers. *Br. J. ind. Med.*, 15, 217-223

- Doll, R., Morgan, L.G. & Speizer, F.E. (1970) Cancers of the lung and nasal sinuses in nickel workers. *Br. J. Cancer*, 24, 623-632
- Doll, R., Mathews, J.D. & Morgan, L.G. (1977) Cancers of the lung and nasal sinuses in nickel workers: a reassessment of the period of risk. *Br. J. ind. Med.*, 34, 102-105
- Drazniowsky, M., Channon, S.M., Parkinson, I.S., Ward, M.K., Poon, T.F.-H. & Kerr, D.N.S. (1985) The measurement of nickel in chronic renal failure. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publications, pp. 141-144
- Dubins, J.S. & LaVelle, J.M. (1986) Nickel(II) genotoxicity: potentiation of mutagenesis of simple alkylating agents. *Mutat. Res.*, 162, 187-199
- Dunnick, J.K., Benson, J.M., Hobbs, C.H., Hahn, F.F., Cheng, Y.S. & Eidson, A.F. (1988) Comparative toxicity of nickel oxide, nickel sulfate hexahydrate, and nickel subsulfide after 12 days of inhalation exposure to F344/N rats and B6C3F₁ mice. *Toxicology*, 50, 145-156
- Dunnick, J.K., Elwell, M.R., Benson, J.M., Hobbs, C.H., Hahn, F.F., Haly, P.J., Cheng, Y.S. & Eidson, A.F. (1989) Lung toxicity after 13-week inhalation exposure to nickel oxide, nickel subsulfide, or nickel sulfate hexahydrate in F344/N rats and B6C3F₁ mice. *Fundam. appl. Toxicol.*, 12, 584-594
- Egedahl, R. & Rice, E. (1984) Cancer incidence at a hydrometallurgical nickel refinery. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 47-55
- Egilsson, V., Evans, I.H. & Wilkie, D. (1979) Toxic and mutagenic effects of carcinogens on the mitochondria of *Saccharomyces cerevisiae*. *Mol. gen. Genet.*, 174, 39-46
- English, J.C., Parker, R.D.R., Sharma, R.P. & Oberg, S.G. (1981) Toxicokinetics of nickel in rats after intratracheal administration of a soluble and insoluble form. *Am. ind. Hyg. Assoc. J.*, 42, 486-492
- Enterline, P.E. & Marsh, G.M. (1982) Mortality among workers in a nickel refinery and alloy manufacturing plant in West Virginia. *J. natl Cancer Inst.*, 68, 925-933
- ERAMET-SLN (Entreprise de Recherches et d'Activités — Métaux — Société le Nickel) (1985) *Electroplating. Nickel Chloride Hexahydrate. Liquid Nickel Chloride*, Paris
- ERAMET-SLN (Entreprise de Recherches et d'Activités — Métaux — Société le Nickel) (1986) *Ferronickel*, Paris
- ERAMET-SLN (Entreprise de Recherche et d'Activités — Métaux — Société le Nickel) (1989a) *Stainless-steel Production*, Paris
- ERAMET-SLN (Entreprise de Recherches et d'Activités — Métaux — Société le Nickel) (1989b) *Nickel Sulfate. Nickel Chloride. Estimated Quantity of Product per Year*, Paris
- Eurométaux (1986) *Data Relating to Nickel Production, Consumption and Application in Europe*, Brussels
- European Chemical Industry Ecology and Toxicology Centre (1989) *Nickel and Nickel Compounds. Review of Toxicology and Epidemiology with Special Reference to Carcinogenesis* (ECETOC Technical Report No. 33), Brussels

- Evans, W.H., Read, J.I. & Lucas, B.E. (1978) Evaluation of a method for the determination of total cadmium, lead and nickel in foodstuffs using measurement by flame atomic absorption spectrophotometry. *Analyst*, 103, 580-594
- Evans, D.J.I., Shoemaker, R.S. & Veltman, H., eds, (1979) *International Laterite Symposium, New Orleans, LA, February 19-21 1979*, New York, Society of Mining Engineers of the American Institute of Mining, Metallurgical and Petroleum Engineers
- Evans, R.M., Davies, P.J.A. & Costa, M. (1982) Video time-lapse microscopy of phagocytosis and intracellular fate of crystalline nickel sulfide particles in cultured mammalian cells. *Cancer Res.*, 42, 2729-2735
- Fairhurst, S. & Illing, H.P.A. (1987) *The Toxicity of Nickel and Its Inorganic Compounds* (Health and Safety Executive Toxicity Review 19), London, Her Majesty's Stationery Office
- Farrell, R.L. & Davis, G.W. (1974) The effects of particulates on respiratory carcinogenesis by diethylnitrosamine. In: Karbe, E. & Park, J.F., eds, *Experimental Lung Cancer, Carcinogenesis and Bioassays*, New York, Springer, pp. 219-233
- Fassett, J.D., Moore, L.J., Travis, J.C. & DeVoe, J.R. (1985) Laser resonance ionization mass spectrometry. *Science*, 230, 262-267
- Feroz, M., Mughal, M.S. & Malik, M.A. (1976) Studies on accumulation of nickel ions in various tissues of the mouse (*Mus musculus*) injected with nickel acetate. *Biologia*, 22, 181-192
- Finch, G.L., Fisher, G.L. & Hayes, T.L. (1987) The pulmonary effects and clearance of intratracheally instilled Ni₃S₂ and TiO₂ in mice. *Environ. Res.*, 42, 83-93
- Fisher, G.L., Crisp, C.E. & McNeill, D.A. (1986) Lifetime effects of intratracheally instilled nickel subsulfide on B6C3F1 mice. *Environ. Res.*, 40, 313-320
- Fletcher, A.C. & Ades, A. (1984) Lung cancer mortality in a cohort of English foundry workers. *Scand. J. Work Environ. Health*, 10, 7-16
- Flora, C.J. & Nieboer, E. (1980) Determination of nickel by differential pulse polarography at a dropping mercury electrode. *Anal. Chem.*, 52, 1013-1020
- Fornace, A.J., Jr (1982) Detection of DNA single-strand breaks produced during the repair of damage by DNA-protein cross-linking agents. *Cancer Res.*, 42, 145-149
- Foulkes, E.C. & McMullen, D.M. (1986) On the mechanism of nickel absorption in the rat jejunum. *Toxicology*, 38, 35-42
- Fukunaga, M., Kurachi, Y. & Mizuguchi, Y. (1982) Action of some metal ions on yeast chromosomes. *Chem. pharm. Bull.*, 30, 3017-3019
- Furst, A. & Al-Mahrouq, H. (1981) Excretion of nickel following intratracheal administration of the carbonate. *Proc. west. Pharmacol. Soc.*, 24, 119-121
- Furst, A. & Cassetta, D. (1973) Carcinogenicity of nickel by different routes (Abstract No. 121). *Proc. Am. Assoc. Cancer Res*, 14, 31
- Furst, A. & Schlauder, M.C. (1971) The hamster as a model for metal carcinogenesis. *Proc. west. Pharmacol. Soc.*, 14, 68-71
- Furst, A., Cassetta, D.M. & Sasmore, D.P. (1973) Rapid induction of pleural mesotheliomas in the rat. *Proc. west. Pharmacol. Soc.*, 16, 150-153

- Gentry, S.J., Howarth, S.R. & Jones, A. (1983) Catalysts. In: Parmeggiani, L., ed., *Encyclopaedia of Occupational Health and Safety*, Geneva, International Labour Office, Vol. 1, pp. 421-426
- Gérin, M., Siemiatycki, J., Richardson, L., Pellerin, J., Lakhani, R. & Dewar, R. (1984) Nickel and cancer associations from a multicancer occupation exposure case-referent study: preliminary findings. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 105-115
- Gilani, S.H. (1982) The effect of nickel upon chick embryo cardiogenesis (Abstract). *Teratology*, 25, 44A
- Gilani, S.H. & Marano, M. (1980) Congenital abnormalities in nickel poisoning in chick embryos. *Arch. environ. Contam. Toxicol.*, 9, 17-22
- Gilman, J.P.W. (1962) Metal carcinogenesis. II. A study of the carcinogenic activity of cobalt, copper, iron, and nickel compounds. *Cancer Res.*, 22, 158-162
- Gilman, J.P.W. (1966) Muscle tumorigenesis. *Can. Cancer Conf.*, 6, 209-223
- Gilman, J.P.W. & Herchen, H. (1963) The effect of physical form of implant on nickel sulphide tumourigenesis in the rat. *Acta unio. int. cancerum*, 19, 615-619
- Gilman, J.P.W. & Ruckerbauer, G.M. (1962) Metal carcinogenesis. I. Observations on the carcinogenicity of a refinery dust, cobalt oxide and colloidal thorium dioxide. *Cancer Res.*, 22, 152-157
- Glaser, U., Hochrainer, D., Oldiges, H. & Takenaka, S. (1986) Long-term inhalation studies with NiO and As₂O₃ aerosols in Wistar rats. *Excerpta med. int. Congr. Sci.*, 676, 325-328
- Glennon, J.D. & Sarkar, B. (1982) Nickel(II) transport in human blood serum. Studies of nickel(II) binding to human albumin and to native-sequence peptide, and ternary-complex formation with L-histidine. *Biochem. J.*, 203, 15-23
- Godbold, J.H., Jr & Tompkins, E.A. (1979) A long-term mortality study of workers occupationally exposed to metallic nickel at the Oak Ridge gaseous diffusion plant. *J. occup. Med.*, 21, 799-806
- Goldberg, M., Goldberg, P., Leclerc, A., Chastang, J.F., Fuhrer, R., Brodeur, J.M., Segnan, N., Floch, J.J. & Michel, G. (1987) Epidemiology of respiratory cancers related to nickel mining and refining in New Caledonia (1978-1984). *Int. J. Cancer*, 40, 300-304
- Goldberg, M., Goldberg, P., Leclerc, A., Chastang, J.F., Marne, M.J., Gueziec, J., Lavigne, F., Dubourdieu, D. & Huerre, M. (1990) A seven-year survey of respiratory cancers among nickel workers in New Caledonia (1978-1984). In: Nieboer, E. & Aitio, A., eds, *Advances in Environmental Science and Technology, Nickel and Human Health: Current Perspectives*, New York, John Wiley & Sons (in press)
- Grandjean, P. (1984) Human exposure to nickel. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 469-485
- Grandjean, P. (1986) *Health Effects Document on Nickel*, Odense, Department of Environmental Medicine, Odense University
- Grandjean, P., Selikoff, I.J., Shen, S.K. & Sunderman, F.W., Jr (1980) Nickel concentrations in plasma and urine of shipyard workers. *Am. J. ind. Med.*, 1, 181-189

- Grandjean, P., Andersen, O. & Nielsen, G.D. (1988) Nickel. In: Alessio, L., Berlin, A., Boni, M. & Roi, R., eds, *Biological Indicators for Assessment of Human Exposure to Industrial Chemicals*, Luxembourg, Commission of the European Communities, pp. 57-81
- Grandjean, P., Nielsen, G.D. & Andersen, O. (1989) Human nickel exposure and chemobio-kinetics. In: Maibach, H.I. & Menné, T., eds, *Nickel and the Skin: Immunology and Toxicology*, Boca Raton, FL, CRC Press, pp. 9-28
- Grice, J.D. & Ferguson, R.B. (1974) Crystal structure refinement of millerite (beta-NiS). *Can. Mineral.*, 12, 248-252
- Gross, H. (1987) Carcinogenic effect of nickel in industry? Conclusions from industrial-medical and epidemiological research, workplace analysis in the steel industry, and legal instructions (Ger.). *Zbl. Arbeitsmed.*, 37, 170-183
- Hackett, R.L. & Sunderman, F.W., Jr (1969) Nickel carbonyl. Effects upon the ultrastructure of hepatic parenchymal cells. *Arch. environ. Health*, 19, 337-343
- Hansen, K. & Stern, R.M. (1983) In vitro toxicity and transformation potency of nickel compounds. *Environ. Health Perspect.*, 51, 223-226
- Hansen, K. & Stern, R.M. (1984) Toxicity and transformation potency of nickel compounds in BHK cells *in vitro*. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 193-200
- Harnett, P.B., Robison, S.H., Swartzendruber, D.E. & Costa, M. (1982) Comparison of protein, RNA, and DNA binding and cell-cycle-specific growth inhibitory effects of nickel compounds in cultured cells. *Toxicol. appl. Pharmacol.*, 64, 20-30
- Hartwig, A. & Beyersmann, D. (1989) Enhancement of UV mutagenesis and sister-chromatid exchanges by nickel ions in V79 cells: evidence for inhibition of DNA repair. *Mutat. Res.*, 217, 65-73
- Hassler, E., Lind, B., Nilsson, B. & Piscator, M. (1983) Urinary and fecal elimination of nickel in relation to air-borne nickel in a battery factory. *Ann. clin. Lab. Sci.*, 13, 217-224
- Hauptverband der gewerblichen Berufsgenossenschaften (Principal Union of Industrial Occupational Associations) (1981) *Von den Berufsgenossenschaften anerkannte Analyseverfahren zur Feststellung der Konzentrationen Krebs erzeugender Arbeitsstoffe in der Luft in Arbeitsbereichen* (Occupational associations for recognized analytical methods to identify concentrates of carcinogenic occupational substances in the air of work environments) (ZH 1/120.10), Cologne, Carl Heymanns, pp. 151-158
- Haworth, S., Lawlor, T., Mortelmans, K., Speck, W. & Zeiger, E. (1983) *Salmonella* mutagenicity test results for 250 chemicals. *Environ. Mutagenesis*, 5 (Suppl. 1), 3-142
- Hayashi, Y., Takahashi, M., Maekawa, A., Kurokawa, Y. & Kokubo, T. (1984) Screening of environmental pollutants for promotion effects on carcinogenesis (Jpn.). In: *Annual Report of the Ministry of Health and Welfare, Japan, for Fiscal Years 1982-1984*, Vol. 20, Tokyo, Ministry of Health and Welfare, pp. 20-1-20-10
- Health and Safety Executive (1987) *Occupational Exposure Limits 1987* (Guidance Note EH 40/87), London, Her Majesty's Stationery Office, pp. 18, 21
- Heath, J.C. & Daniel, M.R. (1964) The production of malignant tumours by nickel in the rat. *Br. J. Cancer*, 18, 261-264

- Heath, J.C. & Webb, M. (1967) Content and intracellular distribution of the inducing metal in the primary rhabdomyosarcomata induced in the rat by cobalt, nickel and cadmium. *Br. J. Cancer*, 21, 768-779
- Heck, J.D. & Costa, M. (1982) In vitro assessment of the toxicity of metal compounds. II. Mutagenesis. *Biol. Trace Elem. Res.*, 4, 319-330
- Heidermanns, G., Wolf, D. & Hoffmann, E. (1983) Nickel exposure on grinding and polishing nickel alloys with nickel proportions below 80% (Ger.). *Staub-Reinhalt. Luft*, 43, 374-376
- Herchen, H. & Gilman, J.P.W. (1964) Effect of duration of exposure on nickel sulphide tumorigenesis. *Nature*, 202, 306-307
- Herlant-Peers, M.C., Hildebrand, H.F. & Biserte, G. (1982) $^{63}\text{Ni}(\text{II})$ incorporation into lung and liver cytosol of Balb/C mouse. An in vitro and in vivo study. *Zbl. Bakt. Hyg., I. Abt. Orig. B*, 176, 368-382
- Hernberg, S., Westerholm, P., Schultz-Larsen, K., Degerth, R., Kuosma, E., Englund, A., Engzell, U., Hansen, H.S. & Mutanen, P. (1983) Nasal and sinonasal cancer. Connection with occupational exposures in Denmark, Finland and Sweden. *Scand. J. Work Environ. Health*, 9, 315-326
- Hildebrand, H.F. & Biserte, G. (1979a) Nickel subsulphide-induced leiomyosarcoma in rabbit white skeletal muscle — a light microscopical and ultrastructural study. *Cancer*, 43, 1358-1374
- Hildebrand, H.F. & Biserte, G. (1979b) Cylindrical laminated bodies in nickel subsulphide-induced rhabdomyosarcoma in rabbits. *Eur. J. Cell Biol.*, 19, 276-280
- Hildebrand, H.F., Collyn-D'Hooghe, M. & Herlant-Peers, M.-C. (1985) Incorporation of $\alpha\text{-Ni}_3\text{S}_2$ and $\beta\text{-NiS}$ into human embryonic pulmonary cells in culture. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publications, pp. 61-64
- Hildebrand, H.F., Collyn-D'Hooghe, M. & Herlant-Peers, M.-C. (1986) Cytotoxicity of nickel derivatives and their incorporation into human embryonic pulmonary epithelial cells (Fr.). *Larc med.*, 6, 249-251
- Hildebrand, H.F., Decaestecker, A.M. & Hetuin, D. (1987) Binding of nickel sulfides to lymphocyte subcellar structures. In: *Trace Elements in Human Health and Disease (Extended Abstracts) from the Second Nordic Symposium, August 1987, Odense* (WHO Environmental Health Series No. 20), Copenhagen, World Health Organization, pp. 82-85
- Hoey, M.J. (1966) The effects of metallic salts on the histology of functioning of the rat testis. *J. Reprod. Fertil.*, 12, 461-471
- Hogan, G.R. (1985) Nickel acetate-induced mortality in mice of different ages. *Bull. environ. Contam. Toxicol.*, 34, 446-450
- Høgetveit, A.C., Barton, R.T. & Kostøl, C.O. (1978) Plasma nickel as a primary index of exposure in nickel refining. *Ann. occup. Hyg.*, 21, 113-120
- Hopfer, S.M., Linden, J.V., Crisostomo, C., O'Brien, J.E. & Sunderman, F.W., Jr (1984) Hypernickelemia in patients receiving disulfiram (Abstract No. 18). *Ann. clin. Lab. Sci.*, 14, 319-320
- Hopfer, S.M., Linden, J.V., Crisostomo, C., Catalanatto, F.A., Galen, M. & Sunderman, F.W., Jr (1985) Hypernickelemia in hemodialysis patients. In: Brown, S.S. & Sunder-

- man, F.W., Jr, eds, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publishers, pp. 133-136
- Horak, E. & Sunderman, F.W., Jr (1973) Fecal nickel excretion by healthy adults. *Clin. Chem.*, *19*, 429-430
- Horak, E. & Sunderman, F.W., Jr (1980) Nephrotoxicity of nickel carbonyl in rats. *Ann. clin. Lab. Sci.*, *10*, 425-431
- Horak, E., Zygowicz, E.R., Tarabishy, R., Mitchell, J.M. & Sunderman, F.W., Jr (1978) Effect of nickel chloride and nickel carbonyl upon glucose metabolism in rats. *Ann. clin. Lab. Sci.*, *8*, 476-482
- Horie, A., Haratake, J., Tanaka, I., Kodama, Y. & Tsuchiya, K. (1985) Electron microscopical findings with special reference to cancer in rats caused by inhalation of nickel oxide. *Biol. Trace Elem. Res.*, *7*, 223-239
- Hueper, W.C. (1952) Experimental studies in metal carcinogenesis. I. Nickel cancers in rats. *Texas Rep. Biol. Med.*, *16*, 167-186
- Hueper, W.C. (1955) Experimental studies in metal carcinogenesis. IV. Cancer produced by parenterally introduced metallic nickel. *J. natl Cancer Inst.*, *16*, 55-67
- Hueper, W.C. (1958) Experimental studies in metal carcinogenesis. IX. Pulmonary lesions in guinea pigs and rats exposed to prolonged inhalation of powdered metallic nickel. *Arch. Pathol.*, *65*, 600-607
- Hueper, W.C. & Payne, W.W. (1962) Experimental studies in metal carcinogenesis. Chromium, nickel, iron, arsenic. *Arch. environ. Health*, *5*, 445-462
- Hui, G. & Sunderman, F.W., Jr (1980) Effects of nickel compounds on incorporation of [³H]-thymidine into DNA in rat liver and kidney. *Carcinogenesis*, *1*, 297-304
- IARC (1973) *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Vol. 2, *Some Inorganic and Organometallic Compounds*, Lyon, pp. 126-149
- IARC (1976) *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Vol. 11, *Cadmium, Nickel, Some Epoxides, Miscellaneous Industrial Chemicals and General Considerations on Volatile Anaesthetics*, Lyon, pp. 87-112
- IARC (1977) *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Vol. 14, *Asbestos*, Lyon
- IARC (1979) *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*, Suppl. 1, *Chemicals and Industrial Processes Associated with Cancer in Humans*, *IARC Monographs Volumes 1 to 20*, Lyon, p. 38
- IARC (1982) *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*, Suppl. 4, *Chemicals, Industrial Processes and Industries Associated with Cancer in Humans*. *IARC Monographs Volumes 1 to 29*, Lyon, pp. 167-170
- IARC (1984) *IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans*, Vol. 34, *Polynuclear Aromatic Compounds, Part 3, Industrial Exposures in Aluminium Production, Coal Gasification, Coke Production, and Iron and Steel Founding*, Lyon, pp. 133-190
- IARC (1987) *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, Suppl. 7, *Overall Evaluations of Carcinogenicity: An Updating of IARC Monographs Volumes 1 to 42*, Lyon, pp. 264-269

- IARC (1988a) *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, Vol. 43, *Man-made Mineral Fibres and Radon*, Lyon, pp. 173-259
- IARC (1988b) *Information Bulletin on the Survey of Chemicals Being Tested for Carcinogenicity*, No. 13, Lyon, pp. 19, 42-43, 250-251
- IARC (1989) *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, Vol. 46, *Diesel and Gasoline Engine Exhausts and Some Nitroarenes*, Lyon, pp. 41-185
- INCO (1981-82) *INCOMOND, Nickel Plating Chemicals*, New York, The International Nickel Company
- INCO (1988) *INCO Specialty Powder Products*, New York, The International Nickel Company
- Institut National de Recherche et de Sécurité (National Institute of Research and Safety) (1986) *Valeurs Limites pour les Concentrations de Substances Dangereuses dans l'Air des Lieux de Travail* (Limit Values for Concentrations of Dangerous Substances in Occupational Air) (DN 1609-125-86), Paris, p. 572
- International Committee on Nickel Carcinogenesis in Man (1990) Report of the International Committee on Nickel Carcinogenesis in Man. *Scand. J. Work Environ. Health*, 16, 1-84
- Ishihara, N., Koizumi, M. & Yoshida, A. (1987) Metal concentrations in human pancreatic juice. *Arch. environ. Health*, 42, 356-360
- Ivankovic, S., Sellar, W.J., Lehmann, E., Komitowski, D. & Frölich, N. (1987) Different carcinogenicity of two nickel alloys following intratracheal administration in the hamster (Abstract No. 103). *Naunyn-Schniederberg's Arch. Pharmacol.*, 335, R26
- Jacobsen, N., Alfheim, I. & Jonsen, J. (1978) Nickel and strontium distribution in some mouse tissues. Passage through placenta and mammary glands. *Res. Commun. chem. Pathol. Pharmacol.*, 20, 571-584
- Jacquet, P. & Mayence, A. (1982) Application of the in vitro embryo culture to the study of the mutagenic effects of nickel in male germ cells. *Toxicol. Lett.*, 11, 193-197
- Jasim, S. & Tjälve, H. (1986) Effects of sodium pyridinethione on the uptake and distribution of nickel, cadmium and zinc in pregnant and non-pregnant mice. *Toxicology*, 38, 327-350
- Jasmin, G. & Riopelle, J.L. (1976) Renal carcinomas and erythrocytosis in rats following intrarenal injection of nickel subsulfide. *Lab. Invest.*, 35, 71-78
- Jiachen, H., Yifen, L., Guazhen, L., Guosan, Z., Chengen, M., Zengxi, L., Shaoyu, S. & Zifeng, Y. (1986) The distribution of trace elements in rats (Chin.). *Acta zool. sin.*, 32, 35-39
- Johansson, A., Camner, P., Jarstrand, C. & Wiernik, A. (1980) Morphology and function of alveolar macrophages after long-term nickel exposure. *Environ. Res.*, 23, 170-180
- Johansson, A., Camner, P. & Robertson, B. (1981) Effects of long-term nickel dust exposure on rabbit alveolar epithelium. *Environ. Res.*, 25, 391-403
- J.T. Baker (1988) *Reagents and Laboratory Products (Catalog 880C)*, Phillipsbury, NJ, pp. 142-143
- Judde, J.G., Breillout, F., Clemenceau, C., Poupon, M.F. & Jasmin, C. (1987) Inhibition of rat natural killer cell function by carcinogenic nickel compounds: preventive action of manganese. *J. natl Cancer Inst.*, 78, 1185-1190

- Kaldor, J., Peto, J., Easton, D., Doll, R., Hermon, C. & Morgan, L. (1986) Models for respiratory cancer in nickel refinery workers. *J. natl Cancer Inst.*, 77, 841-848
- Kanematsu, N., Hara, M. & Kada, T. (1980) Rec assay and mutagenicity studies on metal compounds. *Mutat. Res.*, 77, 109-116
- Kasprzak, K.S. (1974) An autoradiographic study of nickel carcinogenesis in rats following injection of $^{63}\text{Ni}_3\text{S}_2$ and $\text{Ni}_3^{35}\text{S}_2$. *Res. Commun. chem. Pathol. Pharmacol.*, 8, 141-150
- Kasprzak, K.S. (1978) *Problems of Metabolism of the Carcinogenic Nickel Compounds* (Pol.), Poznań, Technical University of Poznań Press
- Kasprzak, K.S. (1987) Nickel. In: Fishbein, L., Furst, A. & Mehlman, M.A., eds, *Advances in Modern Environmental Toxicology*, Vol. XI, *Genotoxic and Carcinogenic Metals: Environmental and Occupational Occurrence and Exposure*, Princeton, NJ, Princeton Scientific Publishing, pp. 145-183
- Kasprzak, K.S. & Bare, R.M. (1989) In vitro polymerization of histones by carcinogenic nickel compounds. *Carcinogenesis*, 10, 621-624
- Kasprzak, K.S. & Poirier, L.A. (1985) Effects of calcium(II) and magnesium(II) on nickel(II) uptake and stimulation of thymidine incorporation into DNA in the lungs of strain A mice. *Carcinogenesis*, 6, 1819-1821
- Kasprzak, K.S. & Sunderman, F.W., Jr (1969) The metabolism of nickel carbonyl- ^{14}C . *Toxicol. appl. Pharmacol.*, 15, 295-303
- Kasprzak, K.S. & Sunderman, F.W., Jr (1977) Mechanisms of dissolution of nickel subsulfide in rat serum. *Res. Commun. chem. Pathol. Pharmacol.*, 16, 95-108
- Kasprzak, K.S., Marchow, L. & Breborowicz, J. (1973) Pathological reactions in rat lungs following intratracheal injection of nickel subsulfide and 3,4-benzpyrene. *Res. Commun. chem. Pathol. Pharmacol.*, 6, 237-245
- Kasprzak, K.S., Gabryel, P. & Jarczewska, K. (1983) Carcinogenicity of nickel(II) hydroxides and nickel(II) sulfate in Wistar rats and its relation to the in vitro dissolution rates. *Carcinogenesis*, 4, 275-279
- Kasprzak, K.S., Waalkes, M.P. & Poirier, L.A. (1986) Antagonism by essential divalent metals and amino acids of nickel(II)-DNA binding *in vitro*. *Toxicol. appl. Pharmacol.*, 82, 336-343
- Kasprzak, K.S., Waalkes, M.P. & Poirier, L.A. (1987) Effects of essential divalent metals on carcinogenicity and metabolism of nickel and cadmium. *Biol. Trace Elem. Res.*, 13, 253-273
- Kettrup, A., Mühlen, T. & Angerer, J. (1985) *Luftanalysen. Analytische Methoden zur Prüfung gesundheitsschädlicher Arbeitsstoffe* (Air Analysis. Analytical Method for Estimating Noxious Workplace Substances), Vol. 1, Weinheim, VCH-Verlagsgesellschaft
- Kiilunen, M., Järvisalo, J., Mäkitie, O. & Aitio, A. (1987) Analysis, storage stability and reference values for urinary chromium and nickel. *Int. Arch. occup. environ. Health*, 59, 43-50
- Kimmel, G.L., Price, C.J., Sonawane, B.R., Rubenstein, R. & Bellin, J.S. (1986) The effect of nickel chloride in drinking water on reproductive and developmental parameters (Abstract No. T12). *Teratology*, 33, 90C

- Kipling, M.D. & Waterhouse, J.A.H. (1967) Cadmium and prostatic carcinoma. *Lancet*, *i*, 730-731
- Klus, H. & Kuhn, H. (1982) Distribution of different tobacco smoke constituents in mainstream and sidestream smoke (A review) (Ger.). *Beitr. Tabakforsch.*, *11*, 229-265
- Knight, J.A., Rezuke, W.N., Gillies, C.G., Hopfer, S.M. & Sunderman, F.W., Jr (1988) Pulmonary histopathology of rats following parenteral injections of nickel chloride. *Toxicol. Pathol.*, *16*, 350-359
- Knutti, R. & Zimmerli, B. (1985) Analysis of daily rations from Swiss canteens and restaurants. III. Lead, cadmium, mercury, nickel and aluminium (Ger.). *Mittel Geb. lebensmittelhyg.*, *76*, 206-232
- Kodama, Y., Tanaka, I., Matsuno, K., Ishimatsu, S., Horie, A. & Tsuchiya, K. (1985) Pulmonary deposition and clearance of inhaled nickel oxide aerosol. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publications, pp. 81-84
- Kollmeier, H., Seemann, J.W., Müller, K.-M., Rothe, G., Wittig, P. & Schejbal, V.B. (1987) Increased chromium and nickel content in lung tissue and bronchial carcinoma. *Am. J. ind. Med.*, *11*, 659-669
- Kollmeier, H., Seemann, J., Müller, K.-M., Schejbal, V., Rothe, G., Wittig, P. & Hummelshelm, G. (1988) Associations between high chromium and nickel concentrations in lung tissue and lung cancer (Ger.). *Prax. klin. Pneumol.*, *42*, 142-148
- König, W., Meis, F.U., Neder, L., Sartori, P., Holtus, G. & Johannsen, H. (1985) *Schadstoffe beim Schleifvorgang* (Hazardous Agents in Grinding Process) (Research No. 427), Dortmund, Bundesanstalt für Arbeitsschutz
- Kretzschmar, J.G., Delespaul, I. & De Rijck, T. (1980) Heavy metal levels in Belgium: a five-year survey. *Sci. total Environ.*, *14*, 85-97
- Kurokawa, Y., Matsushima, M., Imazawa, T., Takamura, N., Takahashi, M. & Hayashi, Y. (1985) Promoting effect of metal compounds on rat renal tumorigenesis. *J. Am. Coll. Toxicol.*, *4*, 321-330
- Larramendy, M.L., Popescu, N.C. & DiPaolo, J.A. (1981) Induction by inorganic metal salts of sister chromatid exchanges and chromosome aberrations in human and Syrian hamster cell strains. *Environ. Mutagenesis*, *3*, 597-606
- Lau, T.J., Hackett, R.L. & Sunderman, F.W., Jr (1972) The carcinogenicity of intravenous nickel carbonyl in rats. *Cancer Res.*, *32*, 2253-2258
- Leach, C.N., Jr & Sunderman, F.W., Jr (1985) Nickel contamination of human serum albumin solutions (Letter to the Editor). *New Engl. J. Med.*, *313*, 1232
- Leach, C.A., Jr & Sunderman, F.W., Jr (1987) Hypernickelemia following coronary arteriography caused by nickel in the radiographic contrast medium. *Ann. clin. Lab. Sci.*, *17*, 137-144
- Lechner, J.F., Tokiwa, T., McClendon, I.A. & Haugen, A. (1984) Effects of nickel sulfate on growth and differentiation of normal human bronchial epithelial cells. *Carcinogenesis*, *5*, 1697-1703

- Lee, J.E., Ciccarelli, R.B. & Wetterhahn-Jennette, K. (1982) Solubilization of the carcinogen nickel subsulfide and its interaction with deoxyribonucleic acid and protein. *Biochemistry*, 21, 771-778
- Léonard, A. & Jacquet, P. (1984) Embryotoxicity and genotoxicity of nickel. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 277-291
- Lessard, R., Reed, D., Maheux, B. & Lambert, J. (1978) Lung cancer in New Caledonia, a nickel smelting island. *J. occup. Med.*, 20, 815-817
- Linden, J.V., Hopfer, S.M., Crisostomo, C., Catalanatto, F., Galen, M. & Sunderman, F.W., Jr (1984) Hypernickelemia in hemodialysis patients (Abstract No. 19). *Ann. clin. Lab. Sci.*, 14, 320
- Liu, T. *et al.* (1983) The role of nickel sulfate in inducing nasopharyngeal carcinoma (NPC) in rats (Abstract). In: *Cancer Research Reports — WHO Collaborating Centre for Research on Cancer*, Vol. 4, Guangzhou, China, Cancer Institute of Zhongshan Medical College, pp. 48-49
- Lloyd, G.K. (1980) Dermal absorption and conjugation of nickel in relation to the induction of allergic contact dermatitis — preliminary results. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, Oxford, London Academic Press, pp. 145-148
- Lu, C.-C., Matsumoto, N. & Iijima, S. (1979) Teratogenic effects of nickel chloride on embryonic mice and its transfer to embryonic mice. *Teratology*, 19, 137-142
- Lu, C.-C., Matsumoto, N. & Iijima, S. (1981) Placental transfer and body distribution of nickel chloride in pregnant mice. *Toxicol. appl. Pharmacol.*, 59, 409-413
- Lundborg, M. & Camner, P. (1984) Lysozyme levels in rabbit lung after inhalation of nickel, cadmium, cobalt, and copper chlorides. *Environ. Res.*, 34, 335-342
- Lundborg, M., Johansson, A. & Camner, P. (1987) Morphology and release of lysozyme following exposure of rabbit lung macrophages to nickel or cadmium *in vitro*. *Toxicology*, 46, 191-203
- Lyell, A., Bain, W.H. & Thomson, R.M. (1978) Repeated failure of nickel-containing prosthetic heart valves in a patient allergic to nickel. *Lancet*, ii, 657-659
- Maenza, R.M., Pradhan, A.M. & Sunderman, F.W., Jr (1971) Rapid induction of sarcomas in rats by combination of nickel sulfide and 3,4-benzpyrene. *Cancer Res.*, 31, 2067-2071
- Magnus, K., Andersen, A. & Høgetveit, A.C. (1982) Cancer of respiratory organs among workers at a nickel refinery in Norway. *Int. J. Cancer*, 30, 681-685
- Maibach, H.I. & Menné, T. (1989) *Nickel and the Skin: Immunology and Toxicology*, Boca Raton, FL, CRC Press
- Malcolm, D. (1983) Batteries, secondary or rechargeable, or accumulators. In: Parmeggiani, L., ed., *Encyclopaedia of Occupational Health and Safety*, 3rd ed., Geneva, International Labour Office, pp. 249-253
- Mallinckrodt, Inc. (1987) *Reagent and Laboratory Chemicals Catalog 1987-88*, St Louis, MO, pp. 167-168
- Mart, L. (1983) Seasonal variations of cadmium, lead, copper and nickel levels in snow from the eastern Arctic Ocean. *Tellus Ser. B*, 35B, 131-141 [*Chem. Abstr.*, 99, 163271x]

- Mas, A., Holt, D. & Webb, M. (1985) The acute toxicity and teratogenicity of nickel in pregnant rats. *Toxicology*, 35, 47-57
- Mas, A., Peligero, M.J., Arola, L. & Alemany, M. (1986) Distribution and kinetics of injected nickel in the pregnant rat. *Clin. exp. Pharmacol. Physiol.*, 13, 91-96
- Mason, M.M. (1972) Nickel sulfide carcinogenesis. *Environ. Physiol. Biochem.*, 2, 137-141
- Mastromatteo, E. (1986) Nickel. *Am. ind. Hyg. Assoc. J.*, 47, 589-601
- Mathur, A.K. & Tandon, S.K. (1981) Urinary excretion of nickel and chromium in occupational workers. *J. environ. Biol.*, 2, 1-6
- Mathur, A.K., Chandra, S.V., Behari, J. & Tandon, S.K. (1977a) Biochemical and morphological changes in some organs of rats in nickel intoxication. *Arch. Toxicol.*, 37, 159-164
- Mathur, A.K., Datta, K.K., Tandon, S.K. & Dikshith, T.S.S. (1977b) Effect of nickel sulphate on male rats. *Bull. environ. Contam. Toxicol.*, 17, 241-248
- Mathur, A.K., Dikshith, T.S.S., Lal, M.M. & Tandon, S.K. (1978) Distribution of nickel and cytogenetic changes in poisoned rats. *Toxicology*, 10, 105-113
- McLean, J.R., McWilliams, R.S., Kaplan, J.G. & Birnboim, H.C. (1982) Rapid detection of DNA strand breaks in human peripheral blood cells and animal organs following treatment with physical and chemical agents. *Prog. Mutat. Res.*, 3, 137-141
- McNeely, M.D., Sunderman, F.W., Jr, Nechay, M.W. & Levine, H. (1971) Abnormal concentrations of nickel in serum in cases of myocardial infarction, stroke, burns, hepatic cirrhosis, and uremia. *Clin. Chem.*, 17, 1123-1128
- McNeely, M.D., Nechay, M.W. & Sunderman, F.W., Jr (1972) Measurements of nickel in serum and urine as indices of environmental exposure to nickel. *Clin. Chem.*, 18, 992-995
- Medinsky, M.A., Benson, J.M. & Hobbs, C.H. (1987) Lung clearance and disposition of ^{63}Ni in F344/N rats after intratracheal instillation of nickel sulfate solutions. *Environ. Res.*, 43, 168-178
- Menné, T., Borgan, Ø. & Green, A. (1982) Nickel allergy and hand dermatitis in a stratified sample of the Danish female population: an epidemiological study including a statistic appendix. *Acta dermatovenerol.*, 62, 35-41
- Menzel, D.B., Deal, D.L., Tayyeb, M.I., Wolpert, R.L., Boger, J.R., III, Shoaf, C.R., Sandy, J., Wilkinson, K. & Francovitch, R.J. (1987) Pharmacokinetic modeling of the lung burden from repeated inhalation of nickel aerosols. *Toxicol. Lett.*, 38, 33-43
- Méranger, J.C., Subramanian, K.S. & Chalifoux, C. (1981) Survey for cadmium, cobalt, chromium, copper, nickel, lead, zinc, calcium and magnesium in Canadian drinking water supplies. *J. Assoc. off. anal. Chem.*, 64, 44-53
- Meyer, A. & Neeb, R. (1985) Determination of cobalt and nickel in some biological matrices — comparison between chelate-gas-chromatography and adsorption-voltammetry (Ger.). *Fresenius Z. anal. Chem.*, 321, 235-241
- Miki, H., Kasprzak, K.S., Kenney, S. & Heine, U.I. (1987) Inhibition of intercellular communication by nickel(II): antagonistic effect of magnesium. *Carcinogenesis*, 8, 1757-1760
- Mitchell, D.F., Shankwalker, G.B. & Shazer, S. (1960) Determining the tumorigenicity of dental materials. *J. dent. Res.*, 31, 1023-1028

- Miyaki, M., Akamatsu, N., Ono, T. & Koyama, H. (1979) Mutagenicity of metal cations in cultured cells from Chinese hamster. *Mutat. Res.*, 68, 259-263
- Mohanty, P.K. (1987) Cytotoxic effect of nickel chloride on the somatic chromosomes of Swiss albino mice *Mus musculus*. *Curr. Sci.*, 56, 1154-1157
- Morgan, J.G. (1958) Some observations on the incidence of respiratory cancer in nickel workers. *Br. J. ind. Med.*, 15, 224-234
- Morgan, L.G. & Rouge, P.J.C. (1979) A study into the correlation between atmospheric and biological monitoring of nickel in nickel refinery workers. *Ann. occup. Hyg.*, 22, 311-317
- Morgan, L.G. & Rouge, P.J.C. (1984) Biological monitoring in nickel refinery workers. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 507-520
- Muhle, H., Bellmann, B., Takenaka, S., Fuhst, R., Mohr, U. & Pott, F. (1990) Chronic effects of intratracheally instilled nickel containing particles in hamsters. In: Nieboer, E. & Aitio, A., eds, *Advances in Environmental Science and Technology, Nickel and Human Health: Current Perspectives*, New York, John Wiley & Sons (in press)
- Mukubo, K. (1978) Studies on experimental lung tumor by the chemical carcinogens and inorganic substances. III. Histopathological studies on lung tumor in rats induced by per-tracheal vinyl tube infusion of 20-methylcholanthrene combined with chromium and nickel powder, (Jpn.). *J. Nara med. Assoc.*, 29, 321-340
- Mushak, P. (1984) Nickel metabolism in health and disease. *Clin. Lab. Ann. Sci.*, 3, 249-269
- Myron, D.R., Zimmerman, T.J., Shuler, T.R., Klevay, L.M., Lee, D.E. & Nielsen, F.H. (1978) Intake of nickel and vanadium by humans. A survey of selected diets. *Am. J. clin. Nutr.*, 31, 527-531
- Nadeenko, V.G., Lenchenko, B.T., Arkhipenko, G.A. & Saichenko, S.P. (1979) Embryotoxic effect of nickel entering the organism by drinking water (Russ.). *Gig. Sanit.*, 6, 86-88
- National Institute for Occupational Safety and Health (1977a) *National Occupational Hazard Survey 1972-74*, Cincinnati, OH
- National Institute for Occupational Safety and Health (1977b) *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Nickel* (DHEW-NIOSH Document, No. 77-164), Washington DC, US Government Printing Office
- National Institute for Occupational Safety and Health (1981) Inorganic nickel, metal and compounds. Method No. 298. In: Taylor, D.G., ed., *NIOSH Manual of Analytical Methods*, Vol. 7, Cincinnati, OH, US Department of Health, Education, and Welfare, pp. 82-100
- National Institute for Occupational Safety and Health (1984) *Manual of Analytical Methods*, 3rd ed., Cincinnati, OH, US Department of Health, Education and Welfare, pp. 7300-1 — 7300-5
- National Institute for Occupational Safety and Health (1988) NIOSH recommendations for occupational safety and health standards. *Morbid. Mortal. Wkly Rep.*, Suppl. 37, S-20
- National Research Council (1975) *Medical and Biological Effects of Environmental Pollutants. Nickel*, Washington DC, Committee on Medical and Biological Effects of Environmental Pollutants, National Academy of Sciences

- Nickel Development Institute (1987a) *High-temperature High-strength Nickel Base Alloys*, Toronto
- Nickel Development Institute (1987b) *Design Guidelines for the Selection and Use of Stainless Steel*, Toronto
- Nieboer, E., Yassi, A., Jusys, A.A. & Muir, D.C.F. (1984a) *The Technical Feasibility and Usefulness of Biological Monitoring in the Nickel Producing Industry (Final Report)*, Toronto, Nickel Producers Environmental Research Association
- Nieboer, E., Maxwell, R.I. & Stafford, A.R. (1984b) Chemical and biological reactivity of insoluble nickel compounds and the bioinorganic chemistry of nickel. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 439-458
- Nieboer, E., Stafford, A.R., Evans, S.L. & Dolovich, J. (1984c) Cellular binding and/or uptake of nickel(II) ions. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 321-331
- Nieboer, E., Maxwell, R.I., Rossetto, F.E., Stafford, A.R. & Stetsko, P.I. (1986) Concepts in nickel carcinogenesis. In: Xavier, A.V., ed., *Frontiers in Bioinorganic Chemistry*, Weinheim, VCH Verlag, pp. 142-151
- Nielsen, F.H. (1980) Interactions of nickel with essential minerals. In: Nriagu, J.O., ed., *Nickel in the Environment*, New York, John Wiley & Sons, pp. 611-634
- Nielsen, G.D. & Flyvholm, M. (1984) Risks of high nickel intake with diet. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 333-338
- Nielsen, F.H., Shuler, T.R., McLeod, T.G. & Zimmerman, T.J. (1984) Nickel influences iron metabolism through physiologic, pharmacologic and toxicologic mechanisms in the rat. *J. Nutr.*, 114, 1280-1288
- Nielsen, G.D., Jørgensen, P.J., Keiding, K. & Grandjean, P. (1987) Urinary nickel excretion before and after loading with naturally occurring nickel. In: *Trace Elements in Human Health and Disease, Abstracts, Second Nordic Symposium, August 1987, Odense University*, Copenhagen, World Health Organization, p. C3
- Nishimura, M. & Umeda, M. (1979) Induction of chromosomal aberrations in cultured mammalian cells by nickel compounds. *Mutat. Res.*, 68, 337-349
- Nishioka, H. (1975) Mutagenic activities of metal compounds in bacteria. *Mutat. Res.*, 31, 185-189
- Niyogi, S.K., Feldman, R.P. & Hoffman, D.J. (1981) Selective effects of metal ions on RNA synthesis rates. *Toxicology*, 22, 9-21
- Norseth, T. (1984) Chromium and nickel. In: Aitio, A., Riihimäti, V. & Vainio, H., eds, *Biological Monitoring and Surveillance of Workers Exposed to Chemicals*, Washington DC, Hemisphere Publishing Corp., pp. 49-59
- Oberdoerster, G. & Hochrainer, D. (1980) Effect of continuous nickel oxide exposure on lung clearance. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, London, Academic Press, pp. 125-128
- Odense University (1986) *Health Effects Document on Nickel*, Odense, Department of Environmental Medicine

- Ogawa, H.I., Tsuruta, S., Niyitani, Y., Mino, H., Sakata, K. & Kato, Y. (1987) Mutagenicity of metal salts in combination with 9-aminoacridine in *Salmonella typhimurium*. *Jpn. J. Genet.*, *62*, 159-162
- Ohno, H., Hanaoka, F. & Yamada, M.-A. (1982) Inducibility of sister-chromatid exchanges by heavy-metal ions. *Mutat. Res.*, *104*, 141-145
- Okamoto, M. (1987) Induction of ocular tumor by nickel subsulfide in the Japanese common newt, *Cynops pyrrhogaster*. *Cancer Res.*, *47*, 5213-5217
- Olejár, S., Olejárová, E. & Vrábel, K. (1982) Neoplasia of the lungs in the workers of a nickel smelting plant (Czech.). *Pracov. Léč.*, *34*, 280-282
- Olsen, I. & Jonsen, J. (1979) Whole body autoradiography of ^{63}Ni in mice throughout gestation. *Toxicology*, *12*, 165-172
- Olsen, J. & Sabroe, S. (1984) Occupational causes of laryngeal cancer. *J. Epidemiol. Commun. Health*, *38*, 117-121
- Onkelinx, C., Becker, J. & Sunderman, F.W., Jr (1973) Compartmental analysis of the metabolism of $^{63}\text{Ni}(\text{II})$ in rats and rabbits. *Res. Commun. chem. Pathol. Pharmacol.*, *6*, 663-676
- Oskarsson, A. & Tjälve, H. (1979a) An autoradiographic study on the distribution of $^{63}\text{NiCl}_2$ in mice. *Ann. clin. Lab. Sci.*, *9*, 47-59
- Oskarsson, A. & Tjälve, H. (1979b) The distribution and metabolism of nickel carbonyl in mice. *Br. J. ind. Med.*, *36*, 326-335
- Oskarsson, A. & Tjälve, H. (1979c) Binding of ^{63}Ni by cellular constituents in some tissues of mice after the administration of $^{63}\text{NiCl}_2$ and $^{63}\text{Ni}(\text{CO})_4$. *Acta pharmacol. toxicol.*, *45*, 306-314
- Oskarsson, A., Andersson, Y. & Tjälve, H. (1979) Fate of nickel subsulfide during carcinogenesis studied by autoradiography and X-ray powder diffraction. *Cancer Res.*, *39*, 4175-4182
- Oskarsson, A., Reid, M.C. & Sunderman, F.W., Jr (1981) Effect of cobalt chloride, nickel chloride, and nickel subsulfide upon erythropoiesis in rats. *Ann. clin. Lab. Sci.*, *11*, 165-172
- Ostapczuk, P., Valenta, P., Stoeppler, M. & Nürnberg, H.W. (1983) Voltammetric determination of nickel and cobalt in body fluids and other biological materials. In: Brown, S.S. & Savory, J., eds, *Chemical Toxicology and Clinical Chemistry of Metals*, London, Academic Press, pp. 61-64
- Ottolenghi, A.D., Haseman, J.K., Payne, W.W., Falk, H.L. & MacFarland, H.N. (1974) Inhalation studies of nickel sulfide in pulmonary carcinogenesis of rats. *J. natl. Cancer Inst.*, *54*, 1165-1172
- Ou, B., Lu, Y., Huang, X. & Feng, G. (1980) The promoting action of nickel in the induction of nasopharyngeal carcinoma in rats (Chin.). In: *Cancer Research Reports — WHO Collaborating Centre for Research on Cancer*, Vol. 2, Guangzhou, Cancer Institute of Zhongshan Medical College, pp. 3-8
- Ou, B., Liu, Y. & Zheng, G. (1983) Tumor induction in next generation of dinitropiperazine-treated pregnant rats (Abstract). In: *Cancer Research Reports — WHO Collaborat-*

- ing Centre for Research on Cancer*, Vol. 4, Guangzhou, Cancer Institute of Zhongshan Medical College, pp. 44-45
- Patierno, S.R. & Costa, M. (1985) DNA-protein cross-links induced by nickel compounds in intact cultured mammalian cells. *Chem.-biol. Interactions*, 55, 75-91
- Patierno, S.R., Sugiyama, M., Basilion, J.P. & Costa, M. (1985) Preferential DNA-protein cross-linking by NiCl₂ in magnesium-insoluble regions of fractionated Chinese hamster ovary cell chromatin. *Cancer Res.*, 45, 5787-5794
- Paton, G.R. & Allison, A.C. (1972) Chromosome damage in human cell cultures induced by metal salts. *Mutat. Res.*, 16, 332-336
- Payne, W.W. (1964) Carcinogenicity of nickel compounds in experimental animals (Abstract No. 197). *Proc. Am. Assoc. Cancer Res.*, 5, 50
- Pedersen, E., Høgetveit, A.C. & Andersen, A. (1973) Cancer of respiratory organs among workers at a nickel refinery in Norway. *Int. J. Cancer*, 12, 32-41
- Peltonen, L. (1979) Nickel sensitivity in the general population. *Contact Dermatitis*, 5, 27-32
- Peto, J., Cuckle, H., Doll, R., Hermon, C. & Morgan, L.G. (1984) Respiratory cancer mortality of Welsh nickel refinery workers. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 37-46
- Pfeiffer, W. & Willert, G. (1986) *Thermisches Spritzen* (Thermal Spraying) (BIA-Report 6), St Augustin, Berufsgenossenschaftliches Institut für Arbeitssicherheit
- Pharmacie Centrale (1988) *Nickel Carbonate*, Paris
- Pienta, R.J., Poiley, J.A. & Lebherz, W.B., III (1977) Morphological transformation of early passage golden Syrian hamster embryo cells derived from cryopreserved primary cultures as a reliable in vitro bioassay for identifying diverse carcinogens. *Int. J. Cancer*, 19, 642-655
- Pihlar, B., Valenta, P. & Nürnberg, H.W. (1981) New high-performance analytical procedure for the voltammetric determination of nickel in routine analysis of waters, biological materials and food. *Fresenius Z. anal. Chem.*, 307, 337-346
- Pikálek, P. & Nečásek, J. (1983) The mutagenic activity of nickel in *Corynebacterium* sp. *Folia Microbiol.*, 28, 17-21
- Poirier, L.A., Theiss, J.C., Arnold, L.J. & Shimkin, M.B. (1984) Inhibition by magnesium and calcium acetates of lead subacetate- and nickel acetate-induced lung tumors in strain A mice. *Cancer Res.*, 44, 1520-1522
- Pott, F., Ziem, U., Reiffer, F.-J., Huth, F., Ernst, H. & Mohr, U. (1987) Carcinogenicity studies on fibres, metal compounds and some other dusts in rats. *Exp. Pathol.*, 32, 129-152
- Pott, F., Rippe, R.M., Roller, M., Csicsaky, M., Rosenbruch, M. & Huth, F. (1989) Tumours in the abdominal cavity of rats after intraperitoneal injection of nickel compounds. In: Vernet, J.-P., ed., *Proceedings of the International Conference on Heavy Metals in the Environment, Geneva, 12-15 September 1989*, Vol. 2, Geneva, World Health Organization, pp. 127-129
- Pott, F., Rippe, R.M., Roller, M., Csicsaky, M., Rosenbruch, M. & Huth, F. (1990) Carcinogenicity studies on nickel compounds and nickel alloys after intraperitoneal injection in rats. In: Nieboer, E. & Aitio, A., *Advances in Environmental Sciences and Toxicology, Nickel and Human Health: Current Perspectives*, New York, John Wiley & Sons (in press)

- Punsar, S., Erämetsä, O., Karvonen, M.J., Ryhänen, A., Hilska, P. & Vornamo, H. (1975) Coronary heart disease and drinking water. A search in two Finnish male cohorts for epidemiologic evidence of a water factor. *J. chron. Dis.*, 28, 259-287
- Queensland Nickel Sales Pty Ltd (1989) *On Nickel Oxide Sinter (90% Ni)*, London
- Raithel, H.J. (1987) *Untersuchungen zur Belastung und Beanspruchung von 837 beruflich Nickel-exponierten Personen* (Studies of Exposure and Effects in 837 Persons Occupationally Exposed to Nickel), St Augustin, Hauptverband der gewerblichen Berufsgenossenschaften
- Raithel, H.-J. & Schaller, K.H. (1981) Toxicity and carcinogenicity of nickel and its compounds. A review of the current status (Ger.). *Zbl. Bakteriol. Hyg. I. Abt. Orig.*, B 173, 63-91
- Raithel, H.-J., Schaller, K.H., Mohrmann, W., Mayer, P. & Henkels, U. (1982) Study of elimination kinetics of nickel during injury in the glass and electroplating industry (Ger.). In: Fliedner, T.M., ed., *Bericht über die 22. Jahrestagung der Deutschen Gesellschaft für Arbeitsmedizin* (Report on the 22nd Anniversary of the German Society of Occupational Medicine), Stuttgart, Gentner, pp. 223-228
- Raithel, H.J., Ebner, G., Schaller, K.H., Schellmann, P. & Valentin, H. (1987) Problems in establishing norm values for nickel and chromium concentrations in human pulmonary tissue. *Am. J. ind. Med.*, 12, 55-70
- Raithel, H.J., Schaller, K.H., Reith, A., Svenes, K.B. & Valentin, H. (1988) Investigations on the quantitative determination of nickel and chromium in human lung tissue. Industrial medical, toxicological, and occupational medical expertise aspects. *Int. Arch. occup. environ. Health*, 60, 55-66
- Rasmuson, Å. (1985) Mutagenic effects of some water-soluble metal compounds in a somatic eye-color test system in *Drosophila melanogaster*. *Mutat. Res.*, 157, 157-162
- Redmond, C.K. (1984) Site-specific cancer mortality among workers involved in the production of high nickel alloys. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 73-86
- Reith, A. & Brøgger, A. (1984) Carcinogenicity and mutagenicity of nickel and nickel compounds. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 175-192
- Rezuke, W.N., Knight, J.A. & Sunderman, F.W., Jr (1987) Reference values for nickel concentrations in human tissues and bile. *Am. J. ind. Med.*, 11, 419-426
- Ridgway, L.P. & Karnofsky, D.A. (1952) The effects of metals on chick embryos: toxicity and production of abnormalities in development. *Ann. N.Y. Acad. Sci.*, 55, 203-215
- Riedel-de Haën (1986) *Laboratory Chemicals*, Hanover, pp. 72, 756-760
- Rigaut, J.P. (1983) *Rapport Préparatoire sur les Critères de Santé pour le Nickel* (Preparatory Report on Health Criteria for Nickel) (Doc. CCE/Lux/V/E/24/83), Luxembourg, Commission of the European Communities
- Rivedal, E. & Sanner, T. (1980) Synergistic effect on morphological transformation of hamster embryo cells by nickel sulphate and benz[a]pyrene. *Cancer Lett.*, 8, 203-208
- Rivedal, E. & Sanner, T. (1981) Metal salts as promoters of *in vitro* morphological transformation of hamster embryo cells initiated by benzo(a)pyrene. *Cancer Res.*, 41, 2950-2953

- Rivedal, E. & Sanner, T. (1983) Evaluation of tumour promoters by the hamster embryo cell transformation assay. In: Bartsch, H. & Armstrong, B., eds, *Host Factors in Human Carcinogenesis* (IARC Scientific Publications No. 39), Lyon, IARC, pp. 251-258
- Rivedal, E., Hemstad, J. & Sanner, T. (1980) Synergistic effects of cigarette smoke extracts, benz(a)pyrene and nickel sulphate on morphological transformation of hamster embryo cells. In: Holmstedt, B., Lauwerys, R., Mercier, M. & Roberfroid, M., eds, *Mechanisms of Toxicity and Hazard Evaluation*, Amsterdam, Elsevier, pp. 259-263
- Roberts, R.S., Julian, J.A., Muir, D.C.F. & Shannon, H.S. (1984) Cancer mortality associated with the high-temperature oxidation of nickel subsulphide. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 23-34
- Roberts, R.S., Julian, J.A., Swezey, D., Muir, D.C.F., Shannon, H.S. & Mastromatteo, E. (1990a) A study of mortality in workers engaged in the mining, smelting, and refining of nickel. I. Methodology and mortality by major case groups. *Toxicol. ind. Health* (in press)
- Roberts, R.S., Julian, J.A., Muir, D.C.F. & Shannon, H.S. (1990b) A study of mortality in workers engaged in the mining, smelting and refining of nickel. II. Mortality from cancer of the respiratory tract and kidney. *Toxicol. ind. Health* (in press)
- Robison, S.H. & Costa, M. (1982) The induction of DNA strand breakage by nickel compounds in cultured Chinese hamster ovary cells. *Cancer Lett.*, 15, 35-40
- Robison, S.H., Cantoni, O. & Costa, M. (1982) Strand breakage and decreased molecular weight of DNA induced by specific metal compounds. *Carcinogenesis*, 5, 657-662
- Robison, S.H., Cantoni, O., Heck, J.D. & Costa, M. (1983) Soluble and insoluble nickel compounds induce DNA repair synthesis in cultured mammalian cells. *Cancer Lett.*, 17, 273-279
- Robison, S.H., Cantoni, O. & Costa, M. (1984) Analysis of metal-induced DNA lesions and DNA-repair replication in mammalian cells. *Mutat. Res.*, 131, 173-181
- Rodriguez-Arnaiz, R. & Ramos, P.M. (1986) Mutagenicity of nickel sulphate in *Drosophila melanogaster*. *Mutat. Res.*, 170, 115-117
- Rossmann, T.G. & Molina, M. (1986) The genetic toxicology of metal compounds: II. Enhancement of ultraviolet light-induced mutagenesis in *Escherichia coli* WP2. *Environ. Mutagenesis*, 8, 263-271
- Rossmann, T.G., Molina, M. & Meyer, L.W. (1984) The genetic toxicology of metal compounds: I. Induction of λ prophage in *E. coli* WP2_s (λ). *Environ. Mutagenesis*, 6, 59-69
- Roush, G.C., Meigs, J.W., Kelly, J.A., Flannery, J.T. & Burdo, H. (1980) Sinonasal cancer and occupation: a case-control study. *Am. J. Epidemiol.*, 111, 183-193
- Rystedt, I. & Fischer, T. (1983) Relationship between nickel and cobalt sensitization in hard metal workers. *Contact Dermatitis*, 9, 195-200
- Saknyn, A.V. & Blokhin, V.A. (1978) Development of malignant tumours in rats exposed to nickel containing aerosols (Russ.). *Vopr. Onkol.*, 24, 44-48
- Saknyn, A.V. & Shabynina, N.K. (1970) Some statistical data on the carcinogenous hazards for workers engaged in the production of nickel from oxidized ores (Russ.). *Gig. Tr. prof. Zabol.*, 14, 10-13

- Saknyn, A.V. & Shabynina, N.K. (1973) Epidemiology of malignant neoplasms in nickel smelters (Russ.). *Gig. Tr. prof. Zabol.*, 17, 25-29
- Saknyn, A.V., Elnichnykh, L.N., Vorontsova, A.S. & Frash, V.N. (1976) General toxic action of dusts generated in the manufacture of crude nickel (Russ.). *Gig. Tr. prof. Zabol.*, 12, 29-32
- Salmon, L., Atkins, D.H.F., Fisher, E.M.R., Healy, C. & Law, D.V. (1978) Retrospective trend analysis on the content of UK air particulate material 1957-1974. *Sci. total Environ.*, 9, 161-200
- Sarkar, B. (1980) Nickel in blood and kidney. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Nickel Toxicology*, London, Academic Press, pp. 81-84
- Sarkar, B. (1984) Nickel metabolism. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 367-384
- Savory, J., Brown, S., Bertholf, R.L., Ross, R. & Wills, M.R. (1985) Serum and lymphocyte nickel and aluminium concentrations in patients with extracorporeal hemodialysis. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publications, pp. 137-140
- Sax, N.I. & Lewis, R.J., Sr (1987) *Hawley's Condensed Chemical Dictionary*, 11th ed., New York, Van Nostrand Reinhold, pp. 818-821
- Saxholm, J.J.K., Reith, A. & Brøgger, A. (1981) Oncogenic transformation and cell lysis in C3H/10T1/2 cells and increased sister chromatid exchange in human lymphocytes by nickel subsulfide. *Cancer Res.*, 41, 4136-4139
- Schaller, K.H. & Zober, A. (1982) Renal elimination of toxicologically relevant metals in occupationally non-exposed individuals (Ger.). *Ärzt. Lab.*, 28, 209-214
- Schaller, K.H., Stoepler, M. & Raithel, H.J. (1982) Analytical determination of nickel in biological matrices. A summary of present knowledge and experience (Ger.). *Staub-Reinhalt. Luft*, 42, 137-140
- Scheller, R., Strahlmann, B. & Schwedt, G. (1988) Chemical and technological aspects of food for a diet poor in nickel for endogenous nickel contact eczema (Ger.). *Hautarzt*, 39, 491-497
- Scholz, R.C. & Holcomb, M.L. (1980) *Feasibility Study for Reduction of Workers Exposures to Nickel and Chromium in Alloy Foundries* (Report submitted to OSHA Docket H-110 by the Foundry Nickel Committee), Washington DC, US Occupational Safety and Health Administration
- Schramel, P., Lill, G. & Hasse, S. (1985) Mineral and trace elements in human urine (Ger.). *J. clin. Chem. clin. Biochem.*, 23, 293-301
- Schroeder, H.A. & Mitchener, M. (1971) Toxic effects of trace elements on the reproduction of mice and rats. *Arch. environ. Health*, 23, 102-106
- Seemann, J., Wittig, P., Kollmeier, H. & Rothe, G. (1985) Analytical measurements of Cd, Pb, Zn, Cr and Ni in human tissues (Ger.). *Lab. Med.*, 9, 294-299
- Sen, P. & Costa, M. (1985) Induction of chromosomal damage in Chinese hamster ovary cells by soluble and particulate nickel compounds: preferential fragmentation of the heterochromatic long arm of the X-chromosome by carcinogenic crystalline NiS particles. *Cancer Res.*, 45, 2320-2325

- Sen, P. & Costa, M. (1986a) Pathway of nickel uptake influences its interaction with heterochromatic DNA. *Toxicol. appl. Pharmacol.*, 84, 278-285
- Sen, P. & Costa, M. (1986b) Incidence and localization of sister chromatid exchanges induced by nickel and chromium compounds. *Carcinogenesis*, 7, 1527-1533
- Sen, P., Conway, K. & Costa, M. (1987) Comparison of the localization of chromosome damage induced by calcium chromate and nickel compounds. *Cancer Res.*, 47, 2142-2147
- Shannon, H.S., Julian, J.A. & Roberts, R.S. (1984a) A mortality study of 11,500 nickel workers. *J. natl Cancer Inst.*, 73, 1251-1258
- Shannon, H.S., Julian, J.A., Muir, D.C.F. & Roberts, R.S. (1984b) A mortality study of Falconbridge workers. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 117-124
- Shibata, M., Izumi, K., Sano, N., Akagi, A. & Otsuka, H. (1989) Induction of soft tissue tumours in F344 rats by subcutaneous, intramuscular, intra-articular, and retroperitoneal injection of nickel sulphide (Ni₃S₂). *J. Pathol.*, 157, 263-274
- Sibley, S.F. (1985) Nickel. In: *Mineral Facts and Problems, 1985 ed.* (Preprint from Bulletin 675), Washington DC, Bureau of Mines, pp. 1-17
- Silverstein, M., Mirer, F., Kotelchuck, D., Silverstein, B. & Bennett, M. (1981) Mortality among workers in a die-casting and electroplating plant. *Scand. J. Work Environ. Health*, 7 (Suppl. 4), 156-165
- Sina, J.F., Bean, C.L., Dysart, G.R., Taylor, V.I. & Bradley, M.O. (1983) Evaluation of the alkaline elution/rat hepatocyte assay as a predictor of carcinogenic/mutagenic potential. *Mutat. Res.*, 113, 357-391
- Sirover, M.A. & Loeb, L.A. (1976) Infidelity of DNA synthesis *in vitro*: screening for potential metal mutagens or carcinogens. *Science*, 194, 1434-1436
- Sirover, M.A. & Loeb, L.A. (1977) On the fidelity of DNA replication: effects of metal activators during synthesis with avian myeloblastosis virus DNA polymerase. *J. biol. Chem.*, 252, 3605-3610
- Skaug, V., Gylseth, B., Reiss, A.-L.P. & Norseth, T. (1985) Tumor induction in rats after intrapleural injection of nickel subsulfide and nickel oxide. In: Brown, S.S. & Sunderman, F.W., Jr, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publications, pp. 37-41
- Škreb, Y. & Fischer, A.B. (1984) Toxicity of nickel for mammalian cells in culture. *Zbl. Bakt. Hyg. I. Abt. Orig. B*, 178, 432-445
- Smart, G.A. & Sherlock, J.C. (1987) Nickel in foods and the diet. *Food Addit. Contam.*, 4, 61-71
- Smialowicz, R.J., Rogers, R.R., Riddle, M.M. & Stott, G.A. (1984) Immunologic effects of nickel: I. Suppression of cellular and humoral immunity. *Environ. Res.*, 33, 413-427
- Smialowicz, R.J., Rogers, R.R., Riddle, M.M., Garner, R.J., Rowe, D.G. & Luebke, R.W. (1985) Immunologic effects of nickel: II. Suppression of natural killer cell activity. *Environ. Res.*, 36, 56-66
- Smialowicz, R.J., Rogers, R.R., Rowe, D.G., Riddle, M.M. & Luebke, R.W. (1987) The effects of nickel on immune function in the rat. *Toxicology*, 44, 271-281

- Smith-Sonneborn, J., Palizzi, R.A., McCann, E.A. & Fisher, G.L. (1983) Bioassay of genotoxic effects of environmental particles in a feeding ciliate. *Environ. Health Perspect.*, *51*, 205-210
- Solomons, N.W., Viteri, F., Shuler, T.R. & Nielsen, F.H. (1982) Bioavailability of nickel in man: effects of foods and chemically-defined dietary constituents on the absorption of inorganic nickel. *J. Nutr.*, *112*, 39-50
- Sonnenfeld, G., Streips, U.N. & Costa, M. (1983) Differential effects of amorphous and crystalline nickel sulfide on murine α/β interferon production. *Environ. Res.*, *32*, 474-479
- Sorahan, T. (1987) Mortality from lung cancer among a cohort of nickel cadmium battery workers: 1946-84. *Br. J. ind. Med.*, *44*, 803-809
- Sorahan, T. & Waterhouse, J.A.H. (1983) Mortality study of nickel-cadmium battery workers by the method of regression models in life tables. *Br. J. ind. Med.*, *40*, 293-300
- Sorahan, T. & Waterhouse, J.A.H. (1985) Cancer of prostate among nickel-cadmium battery workers (Letter). *Lancet*, *i*, 459
- Sorahan, T., Burges, D.C.L. & Waterhouse, J.A.H. (1987) A mortality study of nickel/chromium platers. *Br. J. ind. Med.*, *44*, 250-258
- Sosinski, E. (1975) Morphological changes in rat brain and skeletal muscle in the region of nickel oxide implantation. *Neuropathol. Pol.*, *13*, 479-483
- Stedman, D.H., Tammaro, D.A., Branch, D.K. & Pearson, R., Jr (1979) Chemiluminescence detector for the measurement of nickel carbonyl in air. *Anal. Chem.*, *51*, 2340-2342
- Stettler, L.E., Donaldson, H.M. & Grant, G.C. (1982) Chemical composition of coal and other mineral slags. *Am. ind. Hyg. Assoc. J.*, *43*, 235-238
- Stoeppler, M. (1980) Analysis of nickel in biological materials and natural waters. In: Nriagu, J.O., ed., *Nickel in the Environment*, New York, John Wiley & Sons, pp. 661-822
- Stoeppler, M. (1984a) Analytical chemistry of nickel. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 459-468
- Stoeppler, M. (1984b) Recent improvements for nickel analysis in biological materials. In: *Trace Element Analytical Chemistry*, Vol. 3, Berlin (West), Walter de Gruyter & Co., pp. 539-557
- Stoner, G.D., Shimkin, M.B., Troxell, M.C., Thompson, T.L. & Terry, L.S. (1976) Test for carcinogenicity of metallic compounds by the pulmonary tumor response in strain A mice. *Cancer Res.*, *36*, 1744-1747
- Storeng, R. & Jonsen, J. (1980) Effect of nickel chloride and cadmium acetate on the development of preimplantation mouse embryos *in vitro*. *Toxicology*, *17*, 183-187
- Storeng, R. & Jonsen, J. (1981) Nickel toxicity in early embryogenesis in mice. *Toxicology*, *20*, 45-51
- Sumino, K., Hayakawa, K., Shibata, T. & Kitamura, S. (1975) Heavy metals in normal Japanese tissues. Amount of 15 heavy metals in 30 subjects. *Arch. environ. Health*, *30*, 487-494
- Sunderman, F.W., Jr (1963) Studies of nickel carcinogenesis: alterations of ribonucleic acid following inhalation of nickel carbonyl. *Am. J. clin. Pathol.*, *39*, 549-561

- Sunderman, F.W., Jr (1967) Nickel carbonyl inhibition of cortisone induction of hepatic tryptophan pyrrolase. *Cancer Res.*, 27, 1595-1599
- Sunderman, F.W., Jr (1977) A review of the metabolism and toxicology of nickel. *Ann. clin. Lab. Sci.*, 7, 377-398
- Sunderman, F.W., Jr (1981) Recent research on nickel carcinogenesis. *Environ. Health Perspect.*, 40, 131-141
- Sunderman, F.W., Jr (1983a) Potential toxicity from nickel contamination of intravenous fluids. *Ann. clin. Lab. Sci.*, 3, 1-4
- Sunderman, F.W., Jr (1983b) Organ and species specificity in nickel subsulfide carcinogenesis. *Basic Life Sci.*, 24, 107-127
- Sunderman, F.W., Jr (1984) Carcinogenicity of nickel compounds in animals. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 127-142
- Sunderman, F.W., Jr (1986a) Nickel. In: Seiler, H.G., Sigel, H. & Sigel, A., eds, *Handbook on Toxicity of Inorganic Compounds*, New York, Marcel Dekker, pp. 453-468
- Sunderman, F.W., Jr (1986b) Nickel determination in body fluids, tissues, excreta and water. In: O'Neill, I.K., Schuller, P. & Fishbein, L., eds, *Environmental Carcinogens: Selected Methods of Analysis*, Vol. 8, *Some Metals: As, Be, Cd, Cr, Ni, Pb, Se, Zn* (IARC Scientific Publications No. 72), Lyon, IARC, pp. 319-334
- Sunderman, F.W., Jr (1988) Nickel. In: Clarkson, T.W., Friberg, L., Nordberg, G.F. & Sager, P.R., eds, *Biological Monitoring of Toxic Metals*, New York, Plenum Press, pp. 265-282
- Sunderman, F.W., Jr (1989) Mechanisms of nickel carcinogenesis. *Scand. J. Work Environ. Health*, 15, 1-12
- Sunderman, F.W. & Donnelly, A.J. (1965) Studies on nickel carcinogenesis: metastasizing pulmonary tumors induced by the inhalation of nickel carbonyl. *Am. J. clin. Pathol.*, 46, 1027-1041
- Sunderman, F.W., Jr & Horak, E. (1981) Biochemical indices of nephrotoxicity exemplified by studies of nickel nephropathy. In: Brown, S.S. & Davies, D.S., eds, *Organ-directed Toxicity: Chemical Indices and Mechanisms*, Oxford, Pergamon Press, pp. 55-67
- Sunderman, F.W. & Kincaid, J.F. (1954) Nickel poisoning. II. Studies on patients suffering from acute exposure to vapors of nickel carbonyl. *J. Am. med. Assoc.*, 155, 889-895
- Sunderman, F.W., Jr & Maenza, R.M. (1976) Comparisons of carcinogenicities of nickel compounds in rats. *Res. Commun. chem. Pathol. Pharmacol.*, 14, 319-330
- Sunderman, F.W., Jr & McCully, K.S. (1983) Carcinogenesis tests of nickel arsenides, nickel antimonide, and nickel telluride in rats. *Cancer Invest.*, 1, 469-474
- Sunderman, F.W., Jr & Selin, C.E. (1968) The metabolism of nickel-63 carbonyl. *Toxicol. appl. Pharmacol.*, 12, 207-218
- Sunderman, F.W. & Sunderman, F.W., Jr (1958) Nickel poisoning. VIII. Dithiocarb: a new therapeutic agent for persons exposed to nickel carbonyl. *Am. J. med. Sci.*, 236, 26-31
- Sunderman, F.W. & Sunderman, F.W., Jr (1961) Nickel poisoning. XI. Implication of nickel as a pulmonary carcinogen in tobacco smoke. *Am. J. clin. Pathol.*, 35, 203-209

- Sunderman, F.W., Jr & Sunderman, F.W. (1963) Studies on pulmonary carcinogenesis: the subcellular partition of nickel and the binding of nickel by ribonucleic acids (Abstract No. 1592). *Fed. Proc.*, 22, 427
- Sunderman, F.W., Kincaid, J.F., Donnelly, A.J. & West, B. (1957) Nickel poisoning. IV. Chronic exposure of rats to nickel carbonyl: a report after one year observation. *Arch. environ. Health*, 16, 480-485
- Sunderman, F.W., Donnelly, A.J., West, B. & Kincaid, J.F. (1959) Nickel poisoning. IX. Carcinogenesis in rats exposed to nickel carbonyl. *Arch. environ. Health*, 20, 36-41
- Sunderman, F.W., Jr, Roszel, N.O. & Clark, R.J. (1968) Gas chromatography of nickel. *Arch. environ. Health*, 16, 836-843
- Sunderman, F.W., Jr, Kasprzak, K.S., Lau, T.J., Minghetti, P.P., Maenza, R.M., Becker, N., Onkelinx, C. & Goldblatt, P.J. (1976) Effects of manganese on carcinogenicity and metabolism of nickel subsulfide. *Cancer Res.*, 36, 1790-1800
- Sunderman, F.W., Jr, Shen, S., Mitchell, J., Allpass, P. & Damjanov, I. (1977) Fetal toxicity and transplacental transport of Ni(II) in rats (Abstract No. 176). *Toxicol. appl. Pharmacol.*, 41, 205
- Sunderman, F.W., Jr, Shen, S.K., Mitchell, J.M., Allpass, P.R. & Damjanov, I. (1978a) Embryotoxicity and fetal toxicity of nickel in rats. *Toxicol. appl. Pharmacol.*, 43, 381-390
- Sunderman, F.W., Jr, Mitchell, J., Allpass, P. & Baselt, R. (1978b) Embryotoxicity and teratogenicity of nickel carbonyl in rats (Abstract No. 295). *Toxicol. appl. Pharmacol.*, 45, 345
- Sunderman, F.W., Jr, Maenza, R.M., Hopfer, S.M., Mitchell, J.M., Allpass, P.R. & Damjanov, I. (1979a) Induction of renal cancers in rats by intrarenal injection of nickel subsulfide. *J. environ. Pathol. Toxicol.*, 2, 1511-1527
- Sunderman, F.W., Jr, Allpass, P.R., Mitchell, J.M., Baselt, R.C. & Albert, D.M. (1979b) Eye malformations in rats: induction by prenatal exposure to nickel carbonyl. *Science*, 203, 550-553
- Sunderman, F.W., Jr, Shen, S.K., Reid, M.C. & Allpass, P.R. (1980) Teratogenicity and embryotoxicity of nickel carbonyl in Syrian hamsters. *Teratog. Carcinog. Mutagenesis*, 1, 223-233
- Sunderman, F.W., Jr, McCully, K.S. & Rinehimer, L.A. (1981) Negative test for transplacental carcinogenicity of nickel subsulfide in Fischer rats. *Res. Commun. chem. Pathol. Pharmacol.*, 31, 545-554
- Sunderman, F.W., Jr, Reid, M.C., Bibeau, L.M. & Linden, J.V. (1983a) Nickel induction of microsomal heme oxygenase activity in rodents. *Toxicol. appl. Pharmacol.*, 68, 87-95
- Sunderman, F.W., Jr, Reid, M.C., Shen, S.K. & Kevorkian, C.B. (1983b) Embryotoxicity and teratogenicity of nickel compounds. In: Clarkson, T.W., Nordberg, G.F. & Sager, P.R., eds, *Reproductive and Developmental Toxicity of Metals*, New York, Plenum Press, pp. 399-416
- Sunderman, F.W., Jr, Crisostomo, M.C., Reid, M.C., Hopfer, S.M. & Nomoto, S. (1984a) Rapid analysis of nickel in serum and whole blood by electrothermal atomic absorption spectrophotometry. *Ann. clin. Lab. Sci.*, 14, 232-241

- Sunderman, F.W., Jr, McCully, K.S. & Hopfer, S.M. (1984b) Association between erythrocytosis and renal cancers in rats following intrarenal injection of nickel compounds. *Carcinogenesis*, 5, 1511-1517
- Sunderman, F.W., Jr, Marzouk, A., Crisostomo, M.C. & Weatherby, D.R. (1985a) Electrothermal atomic absorption spectrometry of nickel in tissue homogenates. *Ann. clin. Lab. Sci.*, 15, 299-307
- Sunderman, F.W., Jr, Marzouk, A., Hopfer, S.M., Zaharia, O. & Reid, M.C. (1985b) Increased lipid peroxidation in tissues of nickel chloride-treated rats. *Ann. clin. Lab. Sci.*, 15, 229-236
- Sunderman, F.W., Jr, Aitio, A., Morgan, L.G. & Norseth, T. (1986a) Biological monitoring of nickel. *Toxicol. ind. Health*, 2, 17-78
- Sunderman, F.W., Jr, Hopfer, S.M., Crisostomo, M.C. & Stoeppler, M. (1986b) Rapid analysis of nickel in urine by electrothermal atomic absorption spectrophotometry. *Ann. clin. Lab. Sci.*, 16, 219-230
- Sunderman, F.W., Jr, Hopfer, S.M., Knight, J.A., McCully, K.S., Cecutti, A.G., Thornhill, P.G., Conway, K., Miller, C., Patierno, S.R. & Costa, M. (1987) Physicochemical characteristics and biological effects of nickel oxides. *Carcinogenesis*, 8, 305-313
- Sunderman, F.W., Jr, Hopfer, S.M. & Crisostomo, M.C. (1988a) Nickel analysis by atomic absorption spectrometry. *Methods Enzymol.*, 158, 382-391
- Sunderman, F.W., Jr, Dingle, B., Hopfer, S.M. & Swift, T. (1988b) Acute nickel toxicity in electroplating workers who accidentally ingested a solution of nickel sulfate and nickel chloride. *Am. J. ind. Med.*, 14, 257-266
- Sunderman, F.W., Jr, Hopfer, S.M., Swift, T., Rezuze, W.N., Ziebka, L., Highman, P., Edwards, B., Folcik, M. & Gossling, H.R. (1989a) Cobalt, chromium, and nickel concentrations in body fluids of patients with porous-coated knee or hip prostheses. *J. orthopaed. Res.*, 7, 307-315
- Sunderman, F.W., Jr, Hopfer, S.M., Sweeney, K.R., Marcus, A.H., Most, B.M. & Creason, J. (1989b) Nickel absorption and kinetics in human volunteers. *Proc. Soc. exp. Biol. Med.*, 191, 5-11
- Swierenga, S.H.H. & McLean, J.R. (1985) Further insights into mechanisms of nickel-induced DNA damage: studies with cultured rat liver cells. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publications, pp. 101-104
- Swierenga, S.H.H., Marceau, N., Katsuma, Y., French, S.W., Mueller, R. & Lee, F. (1989) Altered cytokeratin expression and differentiation induction during neoplastic transformation of cultured rat liver cells by nickel subsulfide. *Cell Biol. Toxicol.*, 5, 271-286
- Szadkowski, D., Schultze, H., Schaller, K.-H. & Lehnert, G. (1969) On the ecological significance of heavy metal contents of cigarettes (Ger.) *Arch. Hyg.*, 153, 1-8
- Takenaka, S., Hochrainer, D. & Oldiges, H. (1985) Alveolar proteinosis induced in rats by long-term inhalation of nickel oxide. In: Brown, S.S. & Sunderman, F.W., Jr, eds, *Progress in Nickel Toxicology*, Oxford, Blackwell Scientific Publications, pp. 89-92

- Tanaka, I., Horie, A., Haratake, J., Kodama, Y. & Tsuchiya, K. (1988) Lung burden of green nickel oxide aerosol and histopathological findings in rats after continuous inhalation. *Biol. Trace Elem. Res.*, 16, 19-26
- Tandon, S.K., Mathur, A.K. & Gaur, J.S. (1977) Urinary excretion of chromium and nickel among electroplaters and pigment industry workers. *Int. Arch. occup. environ. Health*, 40, 71-76
- Tatarskaya, A.A. (1965) Occupational cancer of the upper respiratory tract in the nickel-refining industry (Russ.). *Gig. Tr. prof. Zabol.*, 9, 22-25
- Tatarskaya, A.A. (1967) Cancer of the respiratory tract in people engaged in nickel industry (Russ.). *Vopr. Onkol.*, 13, 58-60
- Tien, J.K. & Howson, T.E. (1981) Nickel and nickel alloys. In: Mark, H.F., Othmer, D.F., Overberger, C.G., Seaborg, G.T. & Grayson, M., eds, *Kirk-Othmer Encyclopedia of Chemical Technology*, 3rd ed., Vol. 15, New York, John Wiley & Sons, pp. 787-801
- Tissot, B.P. & Weltle, D. (1984) *Petroleum Formation and Occurrence*, 2nd ed., Berlin (West), Springer
- Tola, S., Kilpiö, J. & Virtamo, M. (1979) Urinary and plasma concentrations of nickel as indicators of exposure to nickel in an electroplating shop. *J. occup. Med.*, 21, 184-188
- Torjussen, W. & Andersen, I. (1979) Nickel concentrations in nasal mucosa, plasma and urine in active and retired nickel workers. *Ann. clin. Lab. Sci.*, 9, 289-298
- Torjussen, W., Haug, F.-M.S. & Andersen, I. (1978) Concentration and distribution of heavy metals in nasal mucosa of nickel-exposed workers and of controls, studied with atomic absorption spectrophotometric analysis and with Timm's sulphide silver method. *Acta otolaryngol.*, 86, 449-463
- Tossavainen, A., Nurminen, M., Mutanen, P. & Tola, S. (1980) Application of mathematical modelling for assessing the biological half-times of chromium and nickel in field studies. *Br. J. ind. Med.*, 37, 285-291
- Tso, W.-W. & Fung, W.-P. (1981) Mutagenicity of metallic cations. *Toxicol. Lett.*, 8, 195-200
- Turhan, U., Wollburg, C., Angerer, J. & Szadkowski, D. (1985) Nickel content of human lungs and its significance for occupational bronchial carcinoma (Ger.). *Arbeitsmed. Sozialmed. Präventivmed.*, 20, 277-281
- Tveito, G., Hansteen, I.-L., Dalen, H. & Haugen, A. (1989) Immortalization of normal human kidney epithelial cells by nickel (II). *Cancer Res.*, 49, 1829-1835
- Tweats, D.J., Green, M.H.L. & Muriel, W.J. (1981) A differential killing assay for mutagens and carcinogens based on an improved repair-deficient strain of *Escherichia coli*. *Carcinogenesis*, 2, 189-194
- Työsuojeluhallitus (National Finnish Board of Occupational Safety and Health) (1987) *HTP-Azvot 1987 (TLV-Values 1987)* (Safety Bull. 25), Helsinki, p. 21
- Tyroler, G.P. & Landolt, C.A., eds (1988) *Extractive Metallurgy of Nickel and Cobalt*, Phoenix, AZ, Metallurgical Society
- Umeda, M. & Nishimura, M. (1979) Inducibility of chromosomal aberrations by metal compounds in cultured mammalian cells. *Mutat. Res.*, 67, 221-229

- US Environmental Protection Agency (1986) *Health Assessment Document for Nickel and Nickel Compounds*, Washington DC, Office of Environmental Health Assessment, pp. 1-83
- US Occupational Safety and Health Administration (1987) Air contaminants. *US Code Fed. Regul., Title 29, Part 1910.1000*, p. 680
- Uziel, M., Owen, B. & Butler, A. (1986) Toxic response of hamster embryo cells on exposure to mixtures of Ni²⁺ and benzo(a)pyrene. *J. appl. Toxicol.*, 6, 167-170
- Valentine, R. & Fisher, G.L. (1984) Pulmonary clearance of intratracheally administered ⁶³Ni₃S₂ in strain A/J mice. *Environ. Res.*, 34, 328-334
- Veien, N.K. & Andersen, M.R. (1986) Nickel in Danish food. *Acta dermato-venerol.*, 66, 502-509
- Veien, N.K., Hattel, T., Justesen, O. & Nørholm, A. (1985) Dietary treatment of nickel dermatitis. *Acta dermatovenerol.*, 65, 138-142
- Vogel, E. (1976) The relation between mutational pattern and concentration by chemical mutagens in *Drosophila*. In: Montesano, R., Bartsch, H. & Tomatis, L., eds, *Screening Tests in Chemical Carcinogenesis* (IARC Scientific Publications No. 12), Lyon, IARC, pp. 117-137
- Vuopala, U., Huhti, E., Takkunen, J. & Huikko, M. (1970) Nickel carbonyl poisoning. Report of 25 cases. *Ann. clin. Res.*, 2, 214-222
- Waalkes, M.P., Rehm, S., Kasprzak, K.S. & Issaq, H.J. (1987) Inflammatory, proliferative and neoplastic lesions at the site of metallic identification ear tags in Wistar [CrI:(WI)BR] rats. *Cancer Res.*, 47, 2445-2450
- Wahlberg, J.E. (1976) Immunoglobulin E, atopy, and nickel allergy. *Cutis*, 18, 715-716, 720
- Waksvik, H. & Boysen, M. (1982) Cytogenetic analyses of lymphocytes from workers in a nickel refinery. *Mutat. Res.*, 103, 185-190
- Waksvik, H., Boysen, M. & Hogetveit, A.C. (1984) Increased incidence of chromosomal aberrations in peripheral lymphocytes of retired nickel workers. *Carcinogenesis*, 5, 1525-1527
- Waltscheva, W., Slatewa, M. & Michailow, I. (1972) Testicular changes due to long-term administration of nickel sulfate in rats (Ger.). *Exp. Pathol.*, 6, 116-120
- Warner, J.S. (1984) Occupational exposure to airborne nickel in producing and using primary nickel products. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 419-437
- Weast, R.C. (1986) *CRC Handbook of Chemistry and Physics*, 67th ed., Boca Raton, FL, CRC Press, pp. B-118-B-119
- Webb, M., Heath, J.C. & Hopkins, T. (1972) Intranuclear distribution of the inducing metal in the primary rhabdomyosarcomata induced in the rat by nickel, cobalt and cadmium. *Br. J. Cancer*, 26, 274-278
- Webster, J.D., Parker, T.F., Alfrey, A.C., Smythe, W.R., Kubo, H., Neal, G. & Hull, A.R. (1980) Acute nickel intoxication by dialysis. *Ann. intern. Med.*, 92, 631-633
- Wehner, A.P., Busch, R.H., Olson, R.J. & Craig, D.K. (1975) Chronic inhalation of nickel oxide and cigarette smoke by hamsters. *Am. ind. Hyg. Assoc. J.*, 36, 801-810

- Wehner, A.P., Stuart, B.O. & Sanders, C.L. (1979) Inhalation studies with Syrian golden hamsters. *Prog. exp. Tumor Res.*, 24, 177-198
- Wehner, A.P., Dagle, G.E. & Milliman, E.M. (1981) Chronic inhalation exposure of hamsters to nickel-enriched fly ash. *Environ. Res.*, 26, 195-216
- Wehner, A.P., Dagle, G.E. & Busch, R.H. (1984) Pathogenicity of inhaled nickel compounds in hamsters. In: Sunderman, F.W., Jr, ed., *Nickel in the Human Environment* (IARC Scientific Publications No. 53), Lyon, IARC, pp. 143-151
- Weinzierl, S.M. & Webb, M. (1972) Interaction of carcinogenic metals with tissue and body fluids. *Br. J. Cancer*, 26, 279-291
- Weischer, C.H., Kördel, W. & Hochrainer, D. (1980a) Effects of NiCl₂ and NiO in Wistar rats after oral uptake and inhalation exposure respectively. *Zbl. Bakt. Hyg. I Abt. Orig. B*, 171, 336-351
- Weischer, C.H., Oldiges, H., Hochrainer, D. & Kördel, W. (1980b) Subchronic effects induced by NiO-inhalation in Wistar rats. In: Holmstedt, B., Lauwerys, R., Mercier, M. & Roberfroid, M., eds, *Mechanisms of Toxicity and Hazard Evaluation*, Amsterdam, Elsevier, pp. 555-558
- Whanger, P.D. (1973) Effects of dietary nickel on enzyme activities and mineral contents in rats. *Toxicol. appl. Pharmacol.*, 25, 323-331
- Wills, M.R., Brown, C.S., Bertholf, R.L., Ross, R. & Savory, J. (1985) Serum and lymphocyte, aluminium and nickel in chronic renal failure. *Clin. chim. Acta*, 145, 193-196
- Wilson, W.W. & Khoobyarian, N. (1982) Potential identification of chemical carcinogens in a viral transformation system. *Chem.-biol. Interactions*, 38, 253-259
- Windholz, M., ed. (1983) *The Merck Index*, 10th ed., Rahway, NJ, Merck & Co., pp. 932-933
- Witschi, H. (1972) A comparative study of in vivo RNA and protein synthesis in rat liver and lung. *Cancer Res.*, 32, 1686-1694
- World Health Organization (1990) *Nickel* (Environmental Health Criteria Document), Geneva (in press)
- Wu, Y., Luo, H. & Johnson, D.R. (1986) Effect of nickel sulfate on cellular proliferation and Epstein-Barr virus antigen expression in lymphoblastoid cell lines. *Cancer Lett.*, 32, 171-179
- Wulf, H.C. (1980) Sister chromatid exchanges in human lymphocytes exposed to nickel and lead. *Dan. med. Bull.*, 27, 40-42
- Yamashiro, S., Gilman, J.P.W., Hulland, T.J. & Abandowitz, H.M. (1980) Nickel sulphide-induced rhabdomyosarcomata in rats. *Acta pathol. jpn.*, 30, 9-22
- Yarita, T. & Nettesheim, P. (1978) Carcinogenicity of nickel subsulfide for respiratory tract mucosa. *Cancer Res.*, 38, 3140-3145
- Zatka, V.J. (1987) *Chemical Speciation of Nickel Phases in Industrial Dusts*, Mississauga, Ontario, INCO Ltd
- Zatka, V.J. (1988) *Report to the NiPERA Scientific Advisory Committee on Interlaboratory Test Programme on Nickel Phase Speciation in Bulk Dust Samples by Sequential Leaching (Phase 3 — Fall 1987)*, Toronto, Nickel Producers Environmental Research Association
- Zatka, V.J., Maskery, D. & Warner, J.S. (undated) *Chemical Speciation of Nickel in Airborne Dusts*, Toronto, Nickel Producers Environmental Research Association

- Zhang, Q. & Barrett, J.C. (1988) Dose-response studies of nickel-induced morphological transformation of Syrian hamster embryo fibroblasts. *Toxicol. In Vitro*, 2, 303-307
- Zhicheng, S. (1986) Acute nickel carbonyl poisoning: a report of 179 cases. *Br. J. ind. Med.*, 43, 422-424
- Zober, A., Weltle, D., Schaller, K.-H. & Valentin, H. (1984) Study on the kinetics of chromium and nickel in biological samples during weekly arc welding with raw materials containing nickel and chromium (Ger.). *Schweissen Schneiden*, 36, 461-464
- Zwennis, W.C.M. & Franssen, A.G. (1983) Exposure to insoluble nickel compounds in a plant for nickel catalysts. Relation between concentrations of nickel in urine and plasma (Abstract). In: *Proceedings of the Second International Conference on Clinical Chemistry and Clinical Toxicology of Metals, Montreal*, p. 128