

ISO/TR 12885:2018-12 (E)

Nanotechnologies - Health and safety practices in occupational settings

Contents		Page
Foreword		v
Introduction		vi
1	Scope	1
2	Normative references	1
3	Terms and definitions	1
4	Symbols and abbreviated terms	1
5	Nanomaterials: Description and manufacturing	3
5.1	Manufactured nanomaterials	3
5.2	Production processes	5
5.2.1	Typical production processes	5
5.2.2	Aerosol generation methods	5
5.2.3	Vapor deposition methods	5
5.2.4	Colloidal/self-assembly methods	5
5.2.5	Electrodeposition	6
5.2.6	Electrospinning	6
5.2.7	Attrition methods	6
6	Hazard characterization	6
6.1	Health effects	6
6.1.1	General	6
6.1.2	Basic principles and uncertainties	7
6.1.3	Potential relevance of health effects information about incidental or naturally-occurring NOAAs	8
6.1.4	Relationship between toxicity and surface area, surface chemistry, and particle number ...	8
6.1.5	Inflammatory response to NOAAs	9
6.1.6	Observations from epidemiological studies involving fine and nanoscale particles	9
6.2	Physical hazards	10
6.2.1	Fire (exothermic events)	10
6.2.2	Safety consideration in manufacturing NOAAs	10
7	Exposure assessment to nanomaterials	10
7.1	General	10
7.2	Scientific framework for assessing exposure to nanomaterials	12
7.2.1	Routes of exposure	12
7.2.2	Metric for assessing exposure to airborne nanomaterials	14
7.3	Review of methods for characterizing exposure to manufactured NOAAs	17
7.3.1	General	17
7.3.2	Sampling strategy issues	20
7.4	Dustiness assessment	24
7.4.1	General	24
7.4.2	Measurement methods	24
7.5	Dermal exposure assessment	25
7.5.1	Sampling	25
7.5.2	Sample characterization	26
7.6	Dose (internal exposure) assessment	26
7.7	Discussion	26

7.8	Summary	27
8	Risk assessment in occupational settings	27
8.1	Introduction and scope	27
8.2	Risk assessment for NOAAs	28
8.2.1	General	28
8.2.2	Quantitative and qualitative risk assessment	28
8.2.3	Hazard identification	29
8.2.4	Exposure-response assessment	29
8.2.5	Exposure assessment	31
8.2.6	Risk characterization	32
8.3	Conclusions	32
9	Risk mitigation approaches	32
9.1	Introduction	32
9.2	Implication of risk assessment in regard to control methodologies	33
9.2.1	Background	33
9.2.2	Strategies for control	34
9.3	Examination of control methodologies	35
9.3.1	Exposure prevention	35
9.3.2	Control strategies	36
9.3.3	Reducing risk through effective design	36
9.3.4	Substitution of raw materials, products, processes and equipment	37
9.3.5	Engineering control techniques	37
9.3.6	Administrative means for the control of workplace exposures	44
9.3.7	Evaluating the work environment	49
9.3.8	Personal protective equipment (PPE)	50
9.4	Health surveillance	55
9.5	Product stewardship	56
	Annex A (informative) Primary chemical composition of nanomaterials	58
	Annex B (informative) Nanomaterial-specific animal and cell culture toxicity studies	66
	Annex C (informative) Characteristics of selected instruments and techniques for monitoring nano-aerosol exposure	78
	Annex D (informative) Characteristics of biosafety cabinets	87
	Annex E (informative) Assigned protection factors for respirators	89
	Annex F (informative) Advantages and disadvantages of different types of air-purifying particulate respirators	90
	Bibliography	93