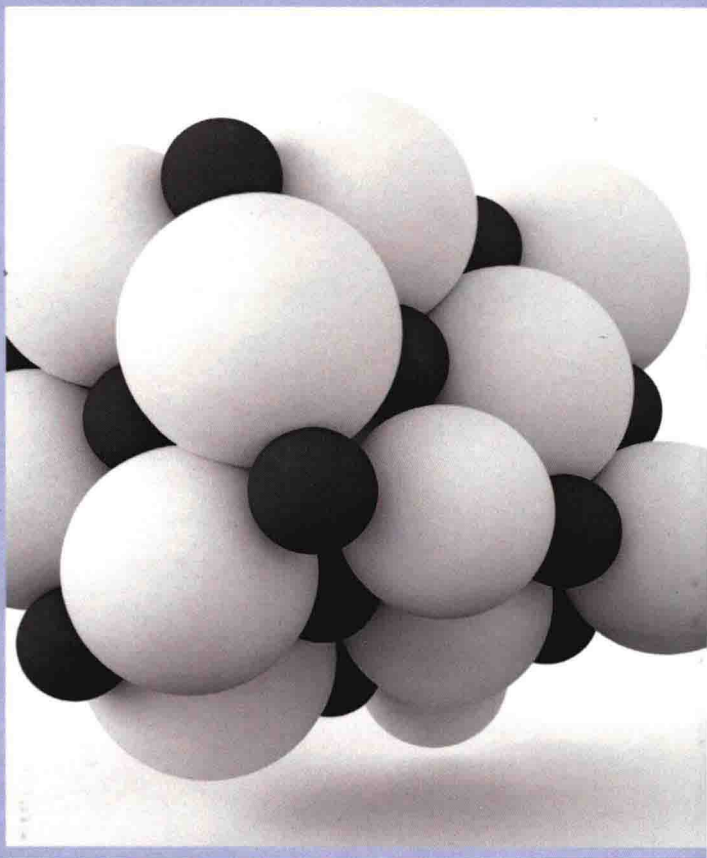
HANDBOOK OF NANOSAFETY

Measurement, Exposure and Toxicology



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MEASUREMENT, EXPOSURE AND TOXICOLOGY

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Foreword

Looking back at previous accidents and occupational diseases one very quickly realizes that most of them, if not all, could have been prevented by better management. Sometimes with better knowledge and design, sometimes with better rules and enforcement and sometimes with better availability of human capacities to face adverse work environments or to run ahead of events.

Looking back at technological progress it is clear that risks evolve; they emerge, get mature and die-out. The emerging phase is very knowledge heavy. Existing knowledge is inadequate to thoroughly understand processes, there is a general tendency to apply old trusted assumptions, technical approaches and mind-sets that worked successfully in the past are, somehow blindly, copied. Uncertainties, conflicting research results and inadequacy of equipment and of skills play their role. Public perceptions do not escape this overall obscure reality. Old technologies that have been successful in ensuring better living conditions are the hardest to replace precisely for their same success.

Risk in itself is only an expectation, an analyst's assessment of possible events with possible adverse effects. As such it does not "exist" outside the analysts' minds. Even a zero value does not mean that the event is impossible; it only means that the analyst (or several analysts) expects that the event is impossible. Risk analysis is, nevertheless, a powerful tool, since it allows scientific insight into the future.

Risk is defined as the product of two probabilities: That the event/hazard occurs and that it has adverse effects. In the case of occupational risks the risk is the product of the probability that a material has a toxic behavior and of the probability that exposure occurs above thresholds that trigger adverse effects.

The hazard quantification depends on the material properties (physical, chemical, biological, etc.), the environment in which the material will be found in the one or the other phase of its life and its behavior with regards to the toxicity end-points considered.

Exposure quantification depends on the material behavior with regard to the possible uptake by organisms, either directly from the original source or indirectly.

Different risks related to the same material and the same exposure scenario do not simply add up. They should come together combined in a risk assessment, which completes the risk analysis.

What comes next is the question of risk acceptance. Acceptance or non-acceptance depends on the value the society as final risk bearer reserves to human health and integrity and to environmental protection and the amount of resources the society accepts to commit. Both vary with space and time. This question, although supported by science, is basically societal in nature, and is outside the scope of this book.

Unacceptable risk needs to be managed by eliminating/reducing the hazard or the exposure or both. It usually requires a decision on the amount of today's resources that can be committed for the benefit of tomorrow. An over-managed risk commits present resources unnecessarily, while an under-managed risk compromises tomorrow's well-being.

Risk management is a different story for which some remarks on regulation need to be recalled.

Regulation essentially consists in formalization of behavior. It is either agreed or imposed. Its driving force is the perception on the side of one societal group that another group does not behave as it would be legitimately expected to by the first. The formalization of behavior is directed to jobs (e.g., building regulation) or to skills (e.g., architect's degree) or both. Violation of regulation is punishable according to pre-set standards and procedures. It is interesting to note that regulation implementation can take an a-posteriori form, punishing for damages that have occurred, or an a-priori form, punishing for behavior that could cause, but has not actually caused, damage.

In this second case the burden of proof falls with the enforcement authority which faces the challenge of objectively measuring both hazard and exposure to demonstrate beyond doubt that risks values, again the value of something that does not physically exist, are in the forbidden area and as a consequence corrective action must be taken. This challenge necessitates scientific knowledge and skills universally recognized as adequate, or simply imposed, for that purpose.

After these words, which simply try to cut short a very long story, the structure of this book is more than evident. After the General Introduction, exposure scenarios are discussed, and the possible Effects of Nanomaterials on Human Health are analyzed. From Source to Dose: Emission, Transport, Aerosol Dynamics and Dose Assessment for Workplace Aerosol Exposure comes next, logically leading to the technologies for Measurement of Aerosol Nanomaterials and the associated Quality Control of Measurement Devices. Exposure Assessment Strategies come next, and the book concludes its main part with the Risk Assessment and Risk Management chapter. Examples and Case Studies are given as guidance, followed by some information on the Safe Use of Nanomaterials and the Future, though this is not the main scope of this book.

Most of the information presented is the result of the hard work mainly undertaken inside the EU-RTD project, NANODEVICE, partly financed

by the NMP programme itself as part of the larger Framework Programme 7 of the European Union. It integrates knowledge from several other projects and sources, and the NANODEVICE team is thankful to all those who one way or another have contributed and continue to do so. It does not claim to provide definitive answers, as this would be unreasonable for any emerging risk, but I hope it will provide the foundation for these answers.

Finally, I wish to thank all the researchers for their groundbreaking work, for their collaboration spirit along many European countries and many scientific cultures, and for the diligence and openness they demonstrated in the very often tough scientific discussions. Many thanks are extended to the project managers and the several chapter editors for their efforts in giving this information the shape of a book that I believe will come out to be a reference for future work.

Georgios Katalagarianakis

Disclaimer

The author expresses his own thoughts not necessarily reflecting those of the EC.

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