The insurability of nanomaterial production risk

Martin Mullins, Finbarr Murphy, Lijana Baublyte, Eamonn M. McAlea and Syed A. M. Tofail

Without insurance the long-term sustainability of nanotechnology is questionable, but insurance companies are encumbered by their institutional memory of losses from the asbestos crisis and the absence of suitable actuarial models to measure the potential risks of nanotechnology. Here we propose a framework that supports the transfer of nanomaterial production risk to the insurance sector.

Insurance has historically played a key but often unheeded role in innovative enterprises ranging from ocean voyages in the seventeenth century to the launch of modern satellites[1,2]. Insurance underwrites the inherent uncertainties associated with expedition, innovation and enterprise, and must occupy a crucial role in the development of nanotechnology[3,4]. At present, nanotechnology liability risks reside outside conventional insurance practice due to the fact that there is no data on the frequency and severity of the insurance losses — information that the underwriter community usually depends on in calculating insurance risk premiums. Also the existing potential for claims accumulation across industries and countries can render the transfer of nanotechnology risk economically unfeasible. This makes the pricing and selection of nanotechnology liability risks an extremely difficult task.

Insuring nanotechnology

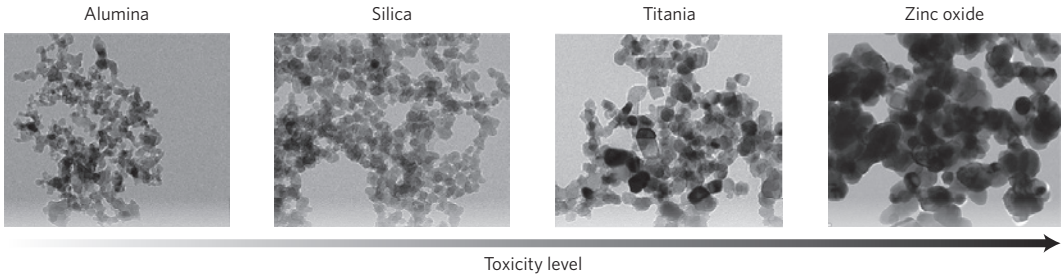
The insurability of nanotechnology is essentially linked with its commercial viability and long-term sustainability. However, it is not a unique problem as the situation is common in the area of emerging risks. The crux of the issue lies in the relative unfamiliarity of the insurance industry with nanotechnology and the fear of a re-emergence of risks such as those associated with asbestos, which is still haunting the insurance industry by incurring financial loss. Although the general public remain largely unaware[5] of any potential risk from nanomaterials or nanomaterial production processes, insurance companies are anxious to achieve a greater understanding of the hazards associated with the nanotech industry. Nanotechnology is one of the key risks that the Lloyd's of London insurance market is tracking, and other large insurers such as Allianz, Munich Re and Swiss Re are now paying close attention to developments in the area of nanomaterials[6]. There have also been efforts to develop risk-management techniques[7–10] but there remains a need to accurately communicate nanotechnology production risk from the nanotech industry to insurance companies. The attitude of the insurance industry towards the insuring of nanotechnology will largely depend on the nanotech industry's understanding of the type of information required to facilitate the transfer of nanomaterial production risk to the insurance sector.

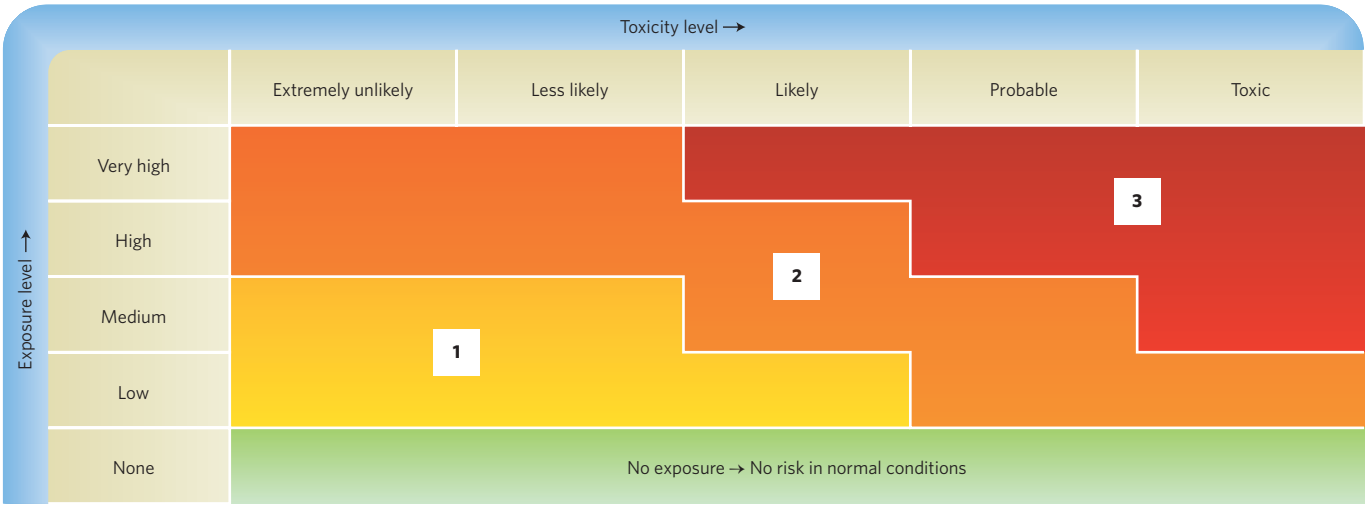
Nanotech industry requires insurance for two principal reasons: first, to efficiently manage risks that arise from running the business (product liability risk, for example) and second, to comply with legal obligations (employer's liability insurance, for example, which is compulsory in a number of countries). Generally, businesses prefer buying employer's liability insurance in combination with additional liability insurance policies such as product, public and environmental coverage. Failure to obtain insurance could result in a breach of the law and result in legal sanction. For smaller companies operating in the nanotech sector adequate insurance coverage is frequently a prerequisite for capital funding.

To assist dialogue between the insurance and nanotechnology sectors, we propose a scalable framework based on control banding that can incorporate existing practices and emerging regulatory changes. Such an approach will facilitate insurance firms in the risk-selection decision-making process to include a particular nanotechnology liability risk in the portfolio of insurance risks. We argue that there is a need for less ambiguity in the treatment of nanomaterials within insurance policies. At present, most liability insurers are implicitly or, in some instances, explicitly covering nanotechnology liability risks as these are not specifically excluded or named in general liability insurance policies. By contrast, the use of asbestos, for example, is explicitly defined in liability insurance contracts and potential insureds are always required to disclose if any part of their business handles, stores, transports or disposes of asbestos.

Current concerns

The legal status of nanotechnology-related activities on existing insurance policies is ambiguous due to reluctance on the part of stakeholders (insurers, industry and regulators) to move beyond the status quo. More specifically, the problem resides in determining whether or not nanotechnology production constitutes a new form of risk, distinct say from the wider chemical sector. Given their avid interest in following developments in the field of nanotoxicology, large insurers are aware of the contested nature of this space and this has fed uncertainty among the underwriting community[11–13]. The existing situation, which can be characterized as a combination of 'wait and see', is not a basis for effective risk management[14]. Despite the fact that nanotechnology activities lie outside prevailing actuarial practices, insurance companies are carrying this risk[15] on their books. This nanoproduction risk pertains to both acute and chronic exposure scenarios. However, determining whether or not nanomaterials hold some latent hazard that may have a significant but delayed impact





Risk level	Situation	Underwriting decision
1 (low)	Acceptable	Insurable
2 (moderate)	To be improved	Insurable subject to extra precautionary measures taken to manage worker's exposure to nanomaterials. This may include adherence to standard operating procedures to reduce exposure or chemical coating to reduce the toxicity (if applicable). Another alternative would be to adjust the contract wording to limit exposure to a claims made basis only (the occurence has to take place during the insured period thus eliminating long-tailed risk).
3 (high)	Unacceptable	Uninsurable

Figure 1 | Control banding for underwriters. Exposure and hazard risk are estimated from qualitative and/or quantitative data and the resultant risk location can be used to calculate the insurance premium. Transmission electron micrographs (top) of nanoparticles of alumina, silica, titania and zinc oxide on an indicative scale of toxicity (levels increase from left to right) based on the data reported in ref. 23. The images of the alumina, silica and titania nanoparticles measure approximately 450 nm across; the image of the zinc oxide nanoparticles measures approximtely 900 nm across. Microscopy images reproduced with permission from ref. 23, © 2011 Elsevier.

will take time. In the insurance sector such potential hazards are referred to as long-tail risks and it is these that are a particular cause for concern among insurers. Indeed, such are the levels of concern in some quarters that certain insurers have vacated the field citing concerns over asbestos-type long-tail risk[16,17].

To improve the insurability of nanomaterials production risk, the insurance sector needs to adjust their existing liability insurance contract wordings to explicitly include nanomaterials. This is paramount as it would allow them to monitor and record the development of potential nanotechnology liability claims. The second step is to integrate a control-banding framework into the underwriting decision-making process. Control banding was developed in the chemical and pharmaceutical industries in the 1980s[7] and since been successfully employed as a quasi-regulatory scheme in different countries. The scheme comprises of a set of protocols designed to minimize the threat of worker exposure to potentially hazardous materials.

A scalable framework

The advancement of a control-banding methodology would be a collaborative effort involving the nanotechnology sector and insurers. This can also reduce the total cost of exposure assessment of nanomaterials if both insurers and producers utilize and/or share the same methodology. Typically the target users for control banding-based analysis are risk

managers and safety officers. It is these professionals that provide the interface between industry and insurance. If the control-banding matrix forms the basis of underwriting decisions, insurers would ultimately take responsibility for where particular nanomaterials would reside within the control-banding tool.

In such a scheme (Fig. 1), both exposure and toxicity potential can be categorized and appropriate risk weightings applied to these categories. The exposure assessment can be performed by scoring different factors such as state of matter (aerosol, powder, liquid form and so on), quantity (experimental or mass production), emission potential (cleanroom environment or open space), frequency and duration of use. The overall score can then be used to determine the level of exposure potential. Similarly, toxicity levels can be assigned with the help of a scientific literature review and lab analysis (that is, *in vivo* and *in vitro* tests) as well as applying scores to parameters such as chemical composition, particle shape, size, surface charge, solubility, aggregation and agglomeration of nanomaterials. Nanotechnology manufacturers have more control over the exposure levels than they have over the toxicity levels.

This framework, with exposure and toxicity as the two principal axes, is something that the insurance sector is familiar with from the pharmaceutical industry and is therefore a useful vehicle for dialogue. By identifying the coordinates of the different exposure and toxicity levels on the control band an insurer can distinguish if a particular risk is acceptable or not for the portfolio of employers' liability risks. Equally, the nanotechnology sector can use the control-banding framework to reduce risk and insurance costs. This control-banding approach is an iterative process whereby greater levels of complexity might be added by the introduction of a third dimension, which could include phenomena such as engineering control, worker training or regulatory jurisdiction.

There are existing control-banding tools for risk management[18] that can be adopted by the insurer. However, a lack of standardization in all areas of nanotechnology is a significant obstacle to their effectiveness as an underwriting tool. This said, international standards organizations[19,20] have made efforts to define nanomaterial characteristics and provide nanomaterial characterization methodologies. Regulators are also now proposing that nanotechnology manufacturers provide physicochemical and application data[21]. Such inputs would be a valuable addition to a control-banding approach. As the framework matures, weightings can be attached to the toxicity and exposure factors and ultimately, a quantitative model can be described that will afford underwriters a sophisticated risk-measurement system. However, in the short term this framework will provide an indicative model allowing insurers to rank the risk associated with various production processes in the nanotechnology sector. The suggested framework is not only useful in terms of risk calculation but also for the wording of the insurance contract. For example, adherence to established guidelines[22] in the handling and use of nanomaterials would be documented in the insurance contract as a condition of cover. Over time this framework will alter risk perceptions among the underwriting community, with nanotechnology activities increasingly differentiated in terms of the risk they represent. In the absence of effective regulatory controls and a lack of legal clarity, control banding will allow nanoparticle production to be put on a more sustainable footing as the science in this emerging area develops. ❐

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