Industrial perspective on emerging risks and safety of nanotechnologies: Results from the EU projects

A. Jovanovic

EU-VRi / Steinbeis Advanced Risk Technologies. Germany / University of Stuttgart, Germany
Abstract

The paper deals with different possible perspectives onto the issue of emerging risks and safety of nanotechnologies, including the nano-toxicology-oriented perspective, the risk assessment oriented perspective and the industrial safety oriented perspective. The latter, is the perspective taken in the a number of EU projects dealing with nanotechnology, especially engineered nanomaterials, on industrial scale. The following issues are tackled more in detail:

(a) recognizing emerging risks, incl. early warnings and managing the available information and knowledge

(b) interdependencies among the risks related to nanotechnologies and other emerging risks, incl. to risk-risk tradeoffs, application of precautionary principle and identification of possible gaps in the research and safety improvement activates related to nanotechnologies

(c) exploring public acceptance and the possibilities model it upfront

The approaches applied in the research projects are reviewed and demonstrated in the presentation. Standardization aspects are tackled in the context of transfer of the research results towards innovation.
Main message: 1+1 could be more than 2!

a. The great investment in nanotechnology R&D projects in the EU should payoff not only in terms of single projects but also at the level of “swarm intelligence”

b. There has not been a “master plan” of R&D projects and/or of the investment in nanotechnology projects, projects approved on case-by-case basis

c. There is no such a thing as “100% nanotechnology project”

<table>
<thead>
<tr>
<th>ContractType</th>
<th>counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-European Fellowships (IEF)</td>
<td>189</td>
</tr>
<tr>
<td>ERC Starting Grant</td>
<td>181</td>
</tr>
<tr>
<td>Collaborative project (generic)</td>
<td>171</td>
</tr>
<tr>
<td>Small or medium-scale focused research project</td>
<td>165</td>
</tr>
<tr>
<td>ERC Advanced Grant</td>
<td>118</td>
</tr>
<tr>
<td>International Incoming Fellowships (IIF)</td>
<td>80</td>
</tr>
<tr>
<td>International Re-integration Grants (IRG)</td>
<td>76</td>
</tr>
<tr>
<td>European Re-integration Grants (ERG)</td>
<td>71</td>
</tr>
<tr>
<td>Large-scale integrating project</td>
<td>69</td>
</tr>
<tr>
<td>Support actions</td>
<td>60</td>
</tr>
<tr>
<td>International research staff exchange scheme (IRSES)</td>
<td>54</td>
</tr>
<tr>
<td>Networks for Initial Training (ITN)</td>
<td>51</td>
</tr>
<tr>
<td>International Outgoing Fellowships (IOF)</td>
<td>48</td>
</tr>
<tr>
<td>Coordination (or networking) actions</td>
<td>46</td>
</tr>
<tr>
<td>No contract type</td>
<td>37</td>
</tr>
<tr>
<td>Research for SMEs</td>
<td>34</td>
</tr>
<tr>
<td>Industry-Academia Partnerships and Pathways (IAPP)</td>
<td>27</td>
</tr>
<tr>
<td>Collaborative Project targeted to a special group (such as SMEs)</td>
<td>24</td>
</tr>
<tr>
<td>Coordination and support actions</td>
<td>21</td>
</tr>
<tr>
<td>Other</td>
<td>52</td>
</tr>
<tr>
<td>Support for training and career development of researcher</td>
<td>8</td>
</tr>
<tr>
<td>Research for SME associations/groupings</td>
<td>5</td>
</tr>
<tr>
<td>Joint Technology Initiatives - Coordination and Support Acti</td>
<td>5</td>
</tr>
</tbody>
</table>
**Baseline**

d. There are over 1,500 projects in CORDIS dealing with or at least partly tackling nanotechnologies (“value”: ~ 3,000 M€?)

e. We have extracted the information about these projects from CORDIS and analyzed it by means of:

- conventional statistics
- data mining and
- semantics
Baseline

d. There are over 1,500 projects in CORDIS dealing with at least partly tackling nanotechnologies.

e. We have extracted the information about these projects from CORDIS and analyzed it by means of:
   - conventional statistics
   - data mining and
   - semantics
Possible perspectives

Different Possible perspectives onto the issue of emerging risks and safety of nanotechnologies

1. the nano-toxicology-oriented perspective
2. the risk assessment oriented perspective and
3. the industrial safety oriented perspective.

0. governance perspective
Possible perspectives

Different Possible perspectives onto the issue of emerging risks and safety of nanotechnologies

1. the nano-toxicology-oriented perspective
2. the risk assessment oriented perspective and
3. the industrial safety oriented perspective.
The industrial safety oriented perspective

The latter, is the perspective taken in the a number of EU projects dealing with nanotechnology, especially engineered nanomaterials, on industrial scale.

Examples:

- **iNTeg-Risk**: Early Recognition, Monitoring and Integrated Management of Emerging, **New Technology Related** Risks
- **Particoat**: New Multipurpose Coating Systems based on Novel Particle Technology for **Extreme Environments at High Temperatures**
- **MATTRANS**: Micro and Nanocrystalline Functionally Graded Materials for **Transport Applications**
- **M-RECT**: Multiscale Reinforcement of Semi-Crystalline Thermoplastic Sheets and Honeycombs
- **MUST**: Multi-level Protection of **Materials For Vehicles** by Smart Nanocontainers
- **Fire-Resist**: Developing Novel **Fire-Resistant High Performance Composites**
- **HELM**: High-frequency Electro-magnetic Technologies for Advanced Processing of Ceramic Matrix Composites and Graphite Expansion
- **Exomet**: Physical Processing of Molten Light Alloys under the Influence of External Fields
- **NanoSTAIR**: A Platform to Support **Standardization**, Innovation and Research in the Field of Nanotechnologies
- **POEMA**: Production of Coatings for New Efficient and Clean Coal **Power Plant Materials**
- **NanoDEVICE**: Novel Concepts, Methods, and Technologies for the Production of Portable, easy-to-use Devices for the Measurement and Analysis of Airborne Engineered Nanoparticles in **Workplace Air**
- **SCAFFOLD**: Innovative Strategies, Methods and Tools for Occupational Risks Management of Manufactured Nanomaterials (mnms) in the **Construction Industry**

All of them involve risks, but look at them from “PERFORMANCE point of view”. …
The industrial safety oriented perspective

patent = (likely) industrial application?

… or, from a “WILL-I-HAVE-PROBLEM-THERE” point of view…
“MUST HSE Material Risk Data Sheets”

Based on:

Guidelines on the Precautionary Matrix for Synthetic Nanomaterials

<table>
<thead>
<tr>
<th>Precautionary Matrix for Synthetic Nanomaterials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Informations</strong></td>
</tr>
<tr>
<td>It is recommended that the relevant accompanying documents be studied before using the precautionary matrix (<a href="http://www.nanotechnologie.admin.ch">www.nanotechnologie.admin.ch</a>)</td>
</tr>
<tr>
<td><strong>Matrix completed by / responsible contact person</strong></td>
</tr>
</tbody>
</table>

| 3. Brief description of the considered nanospecific field (type of NPR, which surrounding, in which application) |
| 4. Brief description of the considered (process) step (production, packaging, transport, further stages of processing, disposal, use…), brief description |

Calculation of the precautionary need for employees

Calculation of the precautionary need for consumers

Is a product requiring nanospecific disposal involved?

Are coated / functionalised NPRs involved?

SAFETY DATA SHEET

MATERIAL SAFETY DATA SHEET

Ekofisk crude oil

3. HAZARDS IDENTIFICATION

- Highly flammable
- Toxic

HEALTH
- Harmful by inhalation.
- May cause cancer.
- May impair fertility.
- Harmful: may cause lung damage if swallowed.

FIRE AND EXPLOSION
- Highly flammable.

ENVIRONMENT
- Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

4. FIRST AID MEASURES

GENERAL
- Immediately move the patient from the source of exposure. If the patient is unconscious, but breathing, maintain open airways and place in stable position on one side. If breathing stops, provide artificial respiration.

INHALATION
- Provide fresh air. Keep the patient warm and at rest. See “General”. Contact physician.

SKIN CONTACT
- Flush with lukewarm water and wash with appropriate soap. Remove contaminated clothing and shoes. Use moisturizing skin cream to replace lost skin moisture. Get medical advice.

EYE CONTACT
- Immediately flush with plenty of water. Keep the eyes wide open. Remove any contact lenses. Continue to rinse for
R-Tech MSDS information in the database

- MSDSs were obtained from 26 different manufacturers from 9 countries.
- Most of the European manufacturers implemented new classifications from the Regulation No.1272/2008 (CLP)
- There was a non-conformity issue in classifications and labeling statements especially in those originated from outside Europe.
R-Tech MSDS information in the database

- 66% of the materials in the database were classified as **hazardous**.

- The most frequent hazard classification are for **known hazards**, e.g., for ENM was flammable solid-category 1 and 2 (H228) and health hazard category was serious eye damage/eye irritation (H319).
The industrial safety oriented perspective

Upscaling = measure of real innovation and industrial applicability?

... or, from a “WILL-IT-WORK-AT-ALL” point of view...

And, often, it does NOT!
The industrial safety oriented perspective

Nanoproduction = measure of innovation applied?

... or, from a “CAN-I-SELL-IT” point of view...

<table>
<thead>
<tr>
<th>Consequences</th>
<th>Probability</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too easy to counterfeit</td>
<td>3.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Nobody Needs It</td>
<td>3</td>
<td>2.2</td>
</tr>
<tr>
<td>Patent app rejected</td>
<td>3.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Leaks of confidentiality</td>
<td>5</td>
<td>2.6</td>
</tr>
<tr>
<td>Unsuitable sales force</td>
<td>5</td>
<td>2.5</td>
</tr>
<tr>
<td>Counterfeit can't be proved</td>
<td>3</td>
<td>2.6</td>
</tr>
<tr>
<td>Project goes against a monopoly</td>
<td>3</td>
<td>2.4</td>
</tr>
<tr>
<td>Too expensive</td>
<td>3.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Does not comply with standards</td>
<td>5</td>
<td>2.8</td>
</tr>
<tr>
<td>Not exploiting exclusivity</td>
<td>3.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Problems at first sales</td>
<td>3.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Rejected by end users</td>
<td>5</td>
<td>2.6</td>
</tr>
<tr>
<td>Standards don't make it compulsory</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

© 2012 Steinbeis Advanced Risk Technologies
The issues

The following issues are tackled more in detail:

(a) recognizing emerging risks, incl. early warnings and managing the available information and knowledge

(b) interdependencies among the risks related to nanotechnologies and other emerging risks, incl. to risk-risk tradeoffs, application of precautionary principle and identification of possible gaps in the research and safety improvement activates related to nanotechnologies

(c) exploring public acceptance and the possibilities model it upfront
The issues

The following issues are tackled more in detail:

(a) recognizing emerging risks, incl. early warnings and managing the available information and knowledge

(b) interdependencies among the risks related to nanotechnologies and other emerging risks, incl. to risk-risk tradeoffs, application of precautionary principle and identification of possible gaps in the research and safety improvement activates related to nanotechnologies

(c) exploring public acceptance and the possibilities model it upfront
Multi-risk, interdependencies & tradeoffs

- Interdependencies among the risks related to nanotechnologies and other emerging risks
- Risk-risk tradeoffs
- Application of precautionary principle
- Identification of possible gaps in the research and safety improvement activates related to nanotechnologies
Multi-risk, interdependencies & tradeoffs

- Interdependencies among the risks related to nanotechnologies and other emerging risks
- Risk-risk tradeoffs
- Application of precautionary principle
- Identification of possible gaps in the research and safety improvement activates related to nanotechnologies
From R&D to innovation (via standardization!)

Main document

“Managing emerging technology-related risks”

based on the iNTeg-Risk Emerging Risk Management Framework

Informative Annex A: Emerging Risks in New Technologies
Informative Annex B: Emerging Risks in New Materials and Products
Informative Annex C: Emerging Risks in New Production Networks
Informative Annex D: Emerging Risk Policies
Informative Annex E: Emerging Risks in Testing Procedures
Structure and content of the CWA 67

Application examples are:
- Materials & Products: Carbon Nanotubes (CNTs)
- Policies: Risk of changing and/or unstable Nano-Regulation in Europe

Informative Annex A: Emerging Risks in New Technologies
Informative Annex B: Emerging Risks in New Materials and Products
Informative Annex C: Emerging Risks in New Production Networks
Informative Annex D: Emerging Risk Policies
Informative Annex E: Emerging Risks in Testing Procedures

October 25, 2012
Conclusions – for nano, it’s much about (public) acceptance; Will perceived benefits outweigh?
Conclusions – for nano, it’s much about (public) acceptance; Will perceived benefits outweigh?
Data from: experts, articles, feed, tweets, ...
Conclusion

• Analyzing life cycle behavior and potential risks of nanotechnologies and products is an ever increasing factor of sustainable success of nanotechnologies and products. This analysis should be comparable among different projects.

• Nanosafety issues for nanotoxicology, nanorisk governance (including regulation), nanorisk assessment and for industrial safety are different, but compatible. Sustainability of the nanotechnology will be ensured only within an integrated approach.

• Ensure that the research related interests of RTD projects match those of industry
Conclusion – “Expertology” of “extended nanosafety”?

Nanosafety Experts

Nanotoxicology Experts

Risk Assessment Experts

Risk Governance Experts

Chemistry / Physics Experts

Biology Experts

(nano) Materials Experts