

Management of emerging risks in future nanocoating applications

7th Framework Programme
EU Project "MUST"

MULTI-LEVEL PROTECTION OF MATERIALS FOR VEHICLES BY "SMART" NANO-CONTAINERS

1. R-Tech at a glance

Steinbeis Advanced Risk Technologies Group (R-Tech) is the cluster of units belonging to and/or linked to Steinbeis (www.stw.de). Over 700 Steinbeis units present in 50+ countries worldwide act today as a global player in the area of innovation management and technology transfer. The group of Steinbeis units working in the area of "Advanced Risk Technologies" deals with multiple aspects of risks, risk engineering and risk management appearing, for instance, in:

- Petro-chemical and process plants
- Power plants and energy supply
- Material technologies, especially advanced material technologies
- New & alternative technologies (CO₂, H₂, nano, ...).

In order to provide the optimal service and results, the R-Tech group has dedicated units for specific area of "advanced risk technologies" such as technology transfer, education, R&D, industrial services ("business-oriented"), and other EU-related issues.

main competence of the center is in the area of assessment, analysis and management of business and technical risks. The center has large experience in co-ordination of European and national stakeholders, promotion of the transfer of technology, introduction of new approach to the risk management. Participation in many EU and international collaborative and purely industrial projects, in both as participant and as coordinator/project manager.

2. Background and introduction to "MUST"

The huge economic impact of environment aggressiveness and corrosion of metallic structures is a very important issue for Europe, which lost more than 200 billion of € for investments every year due to corrosion degradation. Transportation is one of the most important industries with high demand for corrosion resistance. On this demand, application of organic coatings is introduced as a cost effective method of improving the corrosion protection and, therefore, the durability of metallic structures.

Since 2008, the EU project "MUST" is established with high European concerns to advance the protection against corrosion and similar defects is the design, development, upscaling and application of novel multi-level protection systems like coatings and adhesives. The strategy is to respond to destructive conditions with self-healing reactions. This ability is expected to be most effective if it is reacting at certain stages of degradation with different healing processes. A significant improvement of the durability of protective coatings is evident if early stage degradation phenomena are recovered and, for example, decrease of the barrier properties of the coating is postponed to longer exposure times.

3. Advanced material protection

The idea in "MUST" is an extended multi-level protection approach combined within one system, where the protective systems not only reacts adequately to external impacts, but also responds to changes in their internal structure and combine in the same system different damage prevention and reparation mechanisms, depending on the nature and the degree of impact from external environment. The multi-level self-healing concept is based on 4 levels of gradual active feedback to the environmental conditions:

- Incorporation of nanotraps and nanocontainers to absorb aggressive/corrosive species
- Use of water displacing compounds to be released from nanocontainers as soon as the first micro-defect appear in the coating polymer matrix.
- Release of polymerizing precursors entrapped in nanocapsules in order to form a new thin polymer film covering the damaged area and repair the layer by preventing crack propagation.
- Encapsulation of organic and inorganic corrosion inhibitors acting on demand, suppressing corrosion and delaminating processes occurring in open defects.

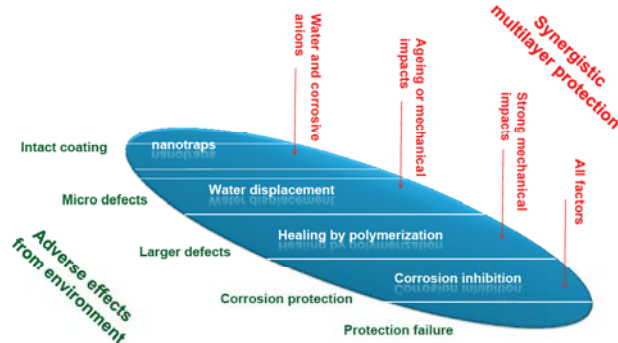


Fig. 1. Gradual feedback of the protective coating to the adverse environmental effects

4. What do we do here?

R-Tech, as one of the main beneficiaries of "MUST", manages the associated risks with the project activities. Main aspects of risks dealt with are:

- Risks in/of innovation (e.g. risks of unexpected side-effects)
- Risk of non- or poor performance (e.g. risks of system or component failures)
- Risk of adverse/unexpected effects and impacts (e.g. public health and environment)
- Project risks, especially in innovation, R&D and new technologies oriented projects.
- Risks over the life-cycle of products/technologies (e.g. unexpected problems in recycling)

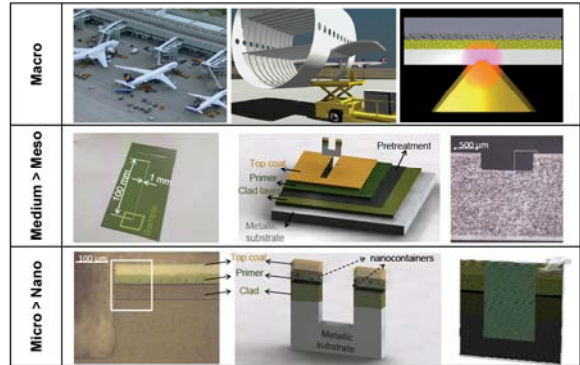


Fig. 2. Multi-scale Modeling and Simulation of self-healing protective coatings

Risk assessment provides an understanding of risks, their causes, consequences and probabilities. Different aspects of risks are assessed by qualitative, semi-quantitative and quantitative methods in order to understand and rank different risks for further analysis and treatment decisions. Furthermore, R-Tech provides dynamic risk treatment techniques by relevant options for reducing the probability of occurrence, or mitigating the effect of risks.

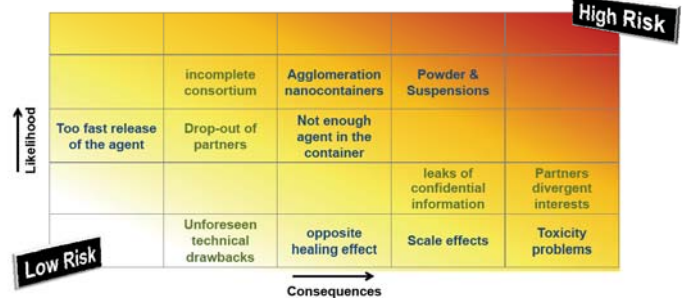
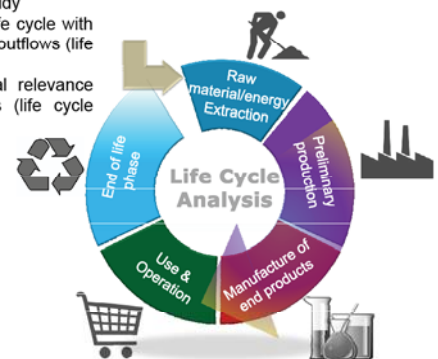


Fig. 3. Multi-scale Modeling and Simulation of self-healing protective coatings

R-Tech offers Life Cycle Assessment (LCA) of new products and technologies. This analysis significantly assists in investigation and evaluation of the environmental impacts of product or service caused by all activities in the project "MUST". R-Tech provides the LCA on innovative products and technologies based on standards ISO 14040 and ISO 14044. This methodology consists of four steps:

1. Defining the goal and scope of study
2. Making a model of the product life cycle with all the environmental inflows and outflows (life cycle inventory, LCI stage)
3. Understanding the environmental relevance of all the inflows and outflows (life cycle impact assessment, LCIA stage)
4. Interpretation of the results



5. "MUST" & future

The main specific target groups for the proposed solution are automotive, aerospace and maritime industries. A high industrial interest is well represented by the participation of main European industrial End-users and suppliers of coatings and adhesives for vehicles. "MUST" will increase considerably the life cycle of materials and therefore boost the competitive strength of the European transport industry. The Multi-level protection approach will also open new opportunities for the application of modern light materials (magnesium and aluminum alloys) in transport industries.