MUST - Publishable Summary 18 Months

The main objective of the MUST project is the design, development, upscaling and application of novel multi-level protection systems like coatings and adhesives for future vehicles and their components to improve radically the long-term performance of metallic substrates and structures. A multi-level self-healing approach will combine - within one system - several damage prevention and reparation mechanisms, which will be activated depending on type and intensity of the environmental impact. The main novel idea claimed in MUST is the multi-level protection approach based on functional nanocontainers. The innovative idea of this project is a gradually active protection response of the coating depending on the nature and the degree of impacts from external environment.

During the first 18 months the RTD work was mainly focused on the following main objectives:

- Definition of industrial requirements to the nanocontainers and selection of model coating and adhesives to be used in project;
- Lab-scale development of nanocontainers for different levels;
- Detailed study of the developed nanocontainers;
- Formulation of coating systems containing nanocontainers;
- Development of novel experimental methods and protocols to evaluate self-healing properties of the developed coatings and adhesives;
- Study of self-healing of novel coatings;
- Modelling of the self-healing processes as well as processes of nanocontainers formation;
- Tests of the industrial coatings and adhesives doped with nanocontainers according to the requirements from respective industries.

The crucial step of the project is the preparation of nanocontainers to be used in self-healing coatings. The activity of six partners during the reporting period was devoted to development of new nanocontainers using different approaches. The main part of this work was focused on nanoreservoirs containing corrosion inhibitors since this approach is of main industrial interest. Several promising solutions were demonstrated for other protection levels as well.

During the reporting period a lot of effort was invested to develop new experimental techniques or tune existing ones for the needs of the project since topic of self-healing coatings is relatively new there is lack of existing and well-established experimental protocols for investigation of the self-healing effects.
The algorithm and computational code for the multilevel protection was developed as well. It considers presence in the multilayer coating water traps and containers with corrosion inhibitor, which can be released upon internal trigger (salt concentration, pH) and calculates transport of water and corrosive ions in the coating.

The first trials on incorporation of nanocontainers to the coating and adhesive formulations for automotive, aerospace and maritime applications have demonstrated that the low amount of available nanoreservoirs doesn’t allow the reproducible conclusive results at the first stage. After delivery the second generation of nanocontainers the new loop of tests was started on modified coating systems in frame of this task. The preliminary tests indicated slightly improved corrosion protection in the case of two tested NCs. This is already a positive result. However the effect must be significantly improved on the later stages. The inhibitor loading capacity in the nano-containers and the total inhibitor amount in the films should be increased. The key issue seems to be compatibility of the developed nanocontainers with commercial coating and adhesive systems. The strong effort of the consortium during the next project period will be focused on the improvement of the developed systems according to the workplan.

The results obtained in the first stage of MUST are promising and demonstrate high chance of success of the project. Application of new developed “smart” high-performance materials will sufficiently strengthen the competitiveness of the European transport industries in particular automotive industry.