FINAL PUBLISHABLE SUMMARY REPORT

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Project acronym: NANOSCRATCH

Project title: TO DEVELOP A SCRATCH RESISTANCE COATING USING A MOLECULAR SELF ASSEMBLY NANO-TECHNOLOGY FOR PLASTIC PRODUCTS.

Funding Scheme: Research for the Benefit of SMEs

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[2] The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm ; logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

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1. Executive Summary

The majority of plastic materials have a limited scratch resistance when compared to other materials, for instance ceramics, glass and metals, resulting in negative aesthetic properties limiting the polymers from being used in a broad range of applications and market sectors. Solving the problem of polymeric surfaces scratching is of the interest of many Industrial companies in many sectors, such as automotive, construction, furniture, among others. several technologies are being researched, such as coatings or laminates or the use of loads (Wollastonite, nanoclays), slip factors or silicone based additives. However, none of these current methods are completely adequate.

In order to solve these disadvantages, a new technology has recently been developed based on molecular self assembly (SAM), and it is one of the most promising techniques to create a coating that is resistant to scratching at a competitive price. With this technology, it is possible to create strong bonds between the coatings and the plastic surfaces regardless of its polarity, maintaining the appearance of the original part. Based on SAM technology, the **NANOSCRATCH** project has worked on the development of an innovative technology for a high performance scratch-resistant coating for plastics, at a low cost, using a custom made environmentally friendly process.

The **NANOSCRATCH** technology is divided in different steps. In general, polymers have a very low surface reactivity. For that reason, a previous oxidation process is a necessary step before linking self-assembly molecules to the plastic surfaces to activate its surface. Different oxidizing agents were studied. All of them were studied over the polymer surfaces to observe the reacted surfaces, if they have enough functional groups on the oxidized surface. Once the surface of the plastic was oxidized, then it was possible to link special molecules. In order to develop an appropriate self-assembly process according to the defined objectives, all of the selected molecules were studied in different conditions: reagents, solvent, concentration of the reagents, temperature of the mixture, application mode, time of application and temperature of drying.

The **main outcomes** of the project are:

o Developing an environmentally friendly and profitable technology for treating the surface of plastic parts. Fundamental knowledge on the treatment of different plastic surfaces and the relationship between the polymer nature and the efficiency and composition of the different treatments has been generated, which has resulted in treatments tailored to the polymer matrix.

o Achieving a significant increase in anti-scratch properties of different polymeric materials: ABS, PMMA or PP/EPDM, increasing the application range in which they can be used.

o The coating technology has been scaled up at pilot-plant level, treating industrial samples. The industrial scale-up has been designed, showing that the costs of producing the different parts are cost-competitive with alternative technology, achieving cost savings up to 60% when there is material substitution. However, further developments are needed in order to effectively industrialise the technology, such as optimisation of coating by spaying in a continuous process.

o The industrialisation of the technology has been supported by Environmental studies (best technologies for the water treatment, analysis of material's recyclability, a Life Cycle Assessment), and a Regulatory analysis. A Guide of Best Practices has also been issued.

This new coating technology developed in the **NANOSCRATCH** project may have a significant impact on the plastic industry; opening a wide range of applications. Although the project's development is aimed at the automotive sector and the white goods industry, the results of the project will be able to be applied to other diverse sectors, such as electronics in computers, DVD or in artificial ceramic surface plates, agriculture, packaged food transport, among others.

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2. Project context and objectives

NANOSCRATCH aimed to develop a novel high performance **scratch resistant coating technology** for plastic pieces at **a low cost using an environmental friendly and tailor-made process**. These new coatings could be applied to low scratch resistance polymers such as polypropylene (PP), PMMA and ABS. These coated plastics can substitute heavy materials, as metallic or glassy components, and high cost engineering plastic materials. The new coating technology to be developed is based on **self assembly nanotechnology**.

Nowadays, plastic materials present limited scratch and mar resistance when compared with materials as ceramics, glass or metals. After a short period of use, plastic parts surface is damaged and aesthetical defects appear (blisters, cracks, scratches…). Scratches can be an ideal breeding ground for bacteria, reducing the hygienic properties of plastics materials. These negative properties limit the usability of plastic materials in a broad range of applications and leading companies are making constant efforts to overcome this challenge. A patent search has revealed a significant number of patents aimed to improve the scratch resistance of plastics materials in the last years.

To tackle this challenge, some approaches are based on improving the performance of the plastic material itself, using special fillers (e.g. wollastonite, clays, alumina oxide or ceramic microspheres), slip additives or silicones based additives mixed directly in a bulk polymer. However, when higher scratch resistance is needed, surface treatment approaches such as transparent coatings (paints) or lamination (ionomer laminates and PVDF films) must be employed. But this solution means higher costs and, in many cases, higher process complexity, labour intensive steps and high scrap ratios.

Physical vapour deposition (PVD), chemical vapour deposition (CVD) and galvanic techniques are the most common coating technologies for high performance applications, employing either vacuum systems or 'wet chemistry'. Galvanic techniques require heavily polluting materials, resulting in significant environmental problems related to waste disposal. In contrast, PVD and CVD are relatively environmentally benign, although CVD is more dangerous and not suitable for thermally and chemically sensitive substrates.

However, PVD has drawbacks. *Although PVD produces superior coatings on flat surfaces, it results in variable coating quality and poor adhesion on 3D components.* Therefore, while PVD is applied in surface hardening of some 95% of machine tools, where small flat surfaces need to be coated over a small area, it is less used for 3D objects such as medical prostheses. A further disadvantage is that, as a vacuum technology, PVD requires long pump-down times and has low deposition rates. This makes PVD techniques more expensive, limiting them to where the performance gain justifies the cost.

As an alternative to current anti-scratch technologies, <u>**NANOSCRATCH main objective**</u> is **to develop a novel technology considering that the surface of certain plastics can be modified through a mild oxidation and chemical functionalization process, using self-assembled molecules (SAM)**. The new coating system is based on water-chemistry technologies. This will provide an effective chemical bond between the plastic surface and the nanoparticle coating, by means of a highly cross-linked network formed at the surface, avoiding the traditional adhesion problems of coatings applied onto plastics, because their low polarity, while maintaining the aspect of the original part**.** The new approach involves three steps: mild oxidation, self-assembly and co-deposition of nanoparticles.

<u>Detailed objectives:</u> in order to achieve the main objective of the project, i.e. the development of high performance anti-scratching coatings based in nano-technologies, several **specific objectives were defined**, such as

1. To develop a **cost effective** and **environmentally friendly** surface treatment technology for plastic pieces to:
    - Increase scratch and mar resistance of plastic pieces.
    - Create strong bonds between the coatings and the plastic surface independently of its polarity and maintaining the aspect of the original part.

2. Allow using inorganic fillers with self-assembly molecules, but without the typical drawbacks associated to their incorporation (loss of transparency, reduced coating flexibility, loss of strength or appearance of defects).
3. To develop a coating that:
   - Has **stronger adhesion** to the substrate than traditional techniques, since there is a chemical bond instead of the physical interaction compared to other processes, providing a 25% improvement in anti-scratch performance
   - **The thin coating does not change the properties of the end product** (i.e., colour, processability, physical characteristics, etc.) nor its recycling process.
   - **Controlled thickness**
   - **Appropriate chemical resistance** for each application: resistance to cleaning products, chemical agents, food, …
   - **Applicable to a wide range of plastic materials and to any shape part**. Although in this project it will be focused on three types of plastics materials; **filled polypropylene** (interior car parts), **ABS** (washing machine external parts and decorative car part) and **PMMA** (transparent parts).
   - **Reduced porosity** compared to other coatings.
4. To develop a coating process that allows:
   - **Reduction of waste generation after the production process:** decrease of the rejected parts and reworking of scratched plastic parts (providing a 35% reduction).
   - **Environmentally friendly coating** since the water used in the process can be easily treated and reused, the raw materials have low vapour pressures thus minimizing evaporation losses and consequently the VOC values will be close to zero.
   - **Low energy consumption**: low temperature process.
   - **Reduction of waste generation after the production process**: decrease of the rejected parts and reworking of scratched plastic parts (providing a 35% reduction).
   - **Low equipment investment** due to the use of standard components and equipments and flexibility to scale up (**the size of the plant can be adapted to the required output**).
   - Flexibility to use a variety of application methods (spraying, immersion), thus making easier to integrate the coating into existing manufacturing processes.
   - **No health concerns** (water based treatments and low toxicity chemicals for high scratch coating process and for waste water treatment).

Finally, besides technical objectives, NANOSCRATCH project aims at **improving the EU Plastic Industry competitiveness,** in particular, but not limited to, companies focused on the **automotive industry** & **White-goods Electrical appliances** market. The European plastics industry makes a significant contribution to the welfare in Europe by enabling innovation, creating quality of life to citizens and facilitating resource efficiency and climate protection. More than 1.6 million people are working in about 50,000 companies (mainly small and medium sized companies in the converting sector) to create a turnover in excess of 280 billion Euros per year (*http://www.plasticsconverters.eu/*).

The achievement of the above mentioned objectives may result in an increase of the competitiveness of the partners which represent the different types of companies involved in the supply chain of scratch resistance plastic parts:

- *Chemical reactants suppliers:* the development of a new technology to improve scratch and mar resistance of plastic parts will represent the expansion of their market since these products will be used in applications where nowadays they are not present.

- *Monitoring and control companies* will diversify their offer, giving their activity a more flexible profile as they will offer new products which are not currently available for automatization of the new plant for SAM technology or similar ones.
- *Extrusion sheet manufacturers:* they will offer to their customer films and sheets of different thermoplastics materials with improved scratch surface resistance properties at a competitive cost. This will lead to an increase in their business offering specialized products.
- *Injection Moulding Plastic parts manufacturers* will offer new plastic parts with better properties (high added-value) without any change of aspect, improving the competitivity of the products and the satisfaction of the end users.
- *Automotive End Users (***tier-one car modules suppliers***).* Automotive tier-one companies produce full parts (doors, roofs, instrument panels) and large plastic or wood parts. They will use the parts produced by the SMEs to manufacture full modules with better performance, lower weight and good recyclability. Besides *The Automotive OEM (Original Equipment Manufacturers)* will increasing the recyclability of components by increase the use of polypropylene instead of other polymers, making the separation and recycling processes easier.
- *White-goods Electrical Appliance End users:* similarly to Automotive tier-one companies, White-Goods Electrical appliances OEMs will obtain as main advantages cost reduction, improved products performance (increased shelf-life, free design of parts, etc.), recyclability (reduce the number of plastic types).

This project has developed a new coating process that after optimisation for industrial use will contribute towards sustainable development. The NANOSCRATCH developments has strengthen the science and technology base of the participating SMEs and has the potential to result in increased competitiveness.

<u>As a summary</u>

Specific innovations of the project are:

- *A molecular self-assembly structure,* as a stable coating at the surface of the plastic piece for superior resistance to scratch will be developed.
- An environmentally friendly surface treatment that can be applied to a broad range of plastic materials (filled PP, PMMA and ABS) with different chemical structure.
- The self-assembling molecules will be joined directly to the mild oxidation surface of the polymers avoiding the use of primers or intermediate coatings reducing the stages of coating preparation giving a cheap, quick and easy coating technology.
- *Non metallic nano-particles* will be co-deposited to obtain a high scratch resistance and transparent coating.
- *Taylor made coatings*. The developed technology will allow controlling the coating thickness and the percentage of nanofillers in order to have different scratch and mar resistance degrees. In other words to create the coating that just fulfil the customer requirements.
- An *environmentally friendly* and sustainable treatment for plastics that avoids the use of hazardous materials or strong treatment that could degrade the surface.
- Perfect dispersion of the nanofillers, due to the fact that dispersive medium is water (high polar solvent) and the nanofiller will be added during organic molecule polymerization.
- Low coating porosity, increasing the coating self-life and performance.
- These features provide great advantages over previous coatings based on sol-gel technologies and others special coating technologies.

3. Main scientific and technological results and foregrounds

The work in the project has been structured in seven work packages, arranged as shown in figure 1.

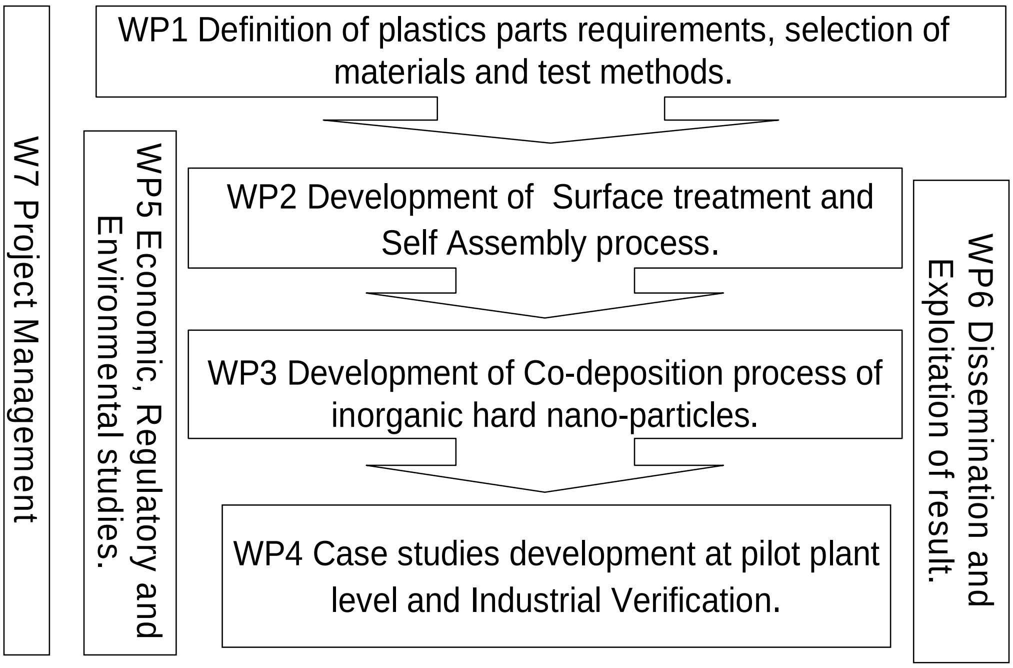

Figure 1. GRAPHICAL PRESENTATION OF THE COMPONENTS SHOWING THEIR INTERDEPENDENCIES (PERT DIAGRAM)

The main scientific and technological results achieved are the following, presented in a WP per WP basis.

WP1 - Definition of plastics parts requirements and materials selection.

The polymer materials that have been studied in the development of the project are:

- Acrylonitrile-Butadiene-Styrene (ABS)
- Talc filled Polypropilene (PPfilled)
- Poly(methyl methacrylate) (PMMA)
- Polypropilene / Ethylene Propylene Diene Monomer (PP/EPDM)

Six case studies have been defined to develop the NANOSCRATCH technology.

- **Case study 1**: Control Panel Body of a washing machine.
- **Case Study 2**: Car Front Door.
- **Case Study 3**: Decorative refrigerator Door.
- **Case study 4**: Wash Machine Door Window.
- **Case Study 5:** Testing cable connector.
- **Case Study 6**: Panel for water heater.

The molecules and particles for the different stages of the SAM process were selected, and a testing methodology for each case study was defined, including mechanical, scratch resistance, impact strength, UV resistance, chemical resistance, etc, depending on the specific requirements of each case-study

WP2 – Development of surface treatment and self assembly process

Development of the mild oxidation and molecular self-assembly processes. The NANOSCRATCH technology is divided in different steps. In general, polymers have a very low surface reactivity. For that reason, a previous oxidation process is a necessary step before linking self-assembly molecules to the plastic surfaces to activate its surface. Different oxidizing agents were studied. All of them were studied over the polymer surfaces to observe the reacted surfaces, if they have enough functional groups on the oxidized surface.

Once the surface of the plastic was oxidized, then it was possible to link special molecules. In order to develop an appropriate self-assembly process according to the defined objectives, all of the selected molecules were studied in different conditions: reagents, solvent, concentration of the reagents, temperature of the mixture, application mode, time of application and temperature of drying. At the beginning of the study, it was observed different behaviours depending on the grade of the polymer, which implies that the treatments have to be optimised tailored to each material characteristics. Figure 2 shows a SEM (scanning electron microscope) picture made to check how surface was modified.

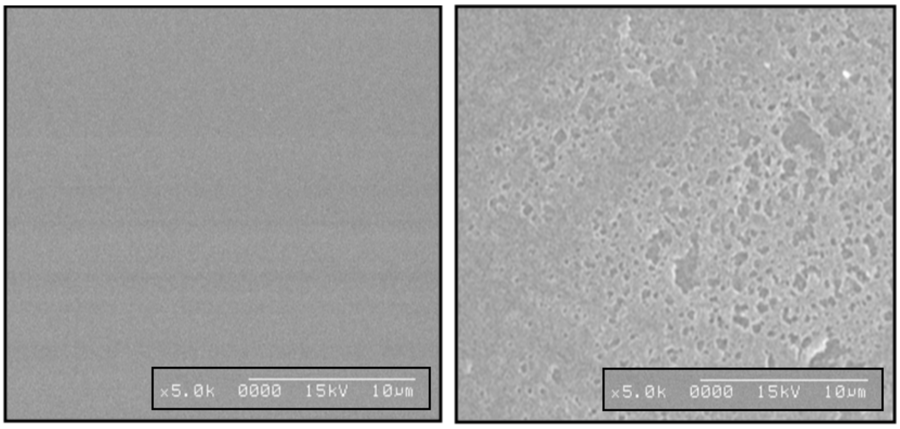

Figure 2: a) Surface of a pure PMMA specimen. b) Surface of an oxidized PMMA specimen.

The next step in NANOSCRATCH technology is the deposition of the nanoparticles in order to be linked to the self-assembly molecules, which are in turn linked to the polymer oxidized surface. Prior to this stage, the nanoparticles have been functionalized in order to create functional groups on their surface and subsequent bond between the nanoparticles and self-assembly molecules. Figure 3 shows a SEM (scanning electron microscope) picture to check how the surface has been modified.

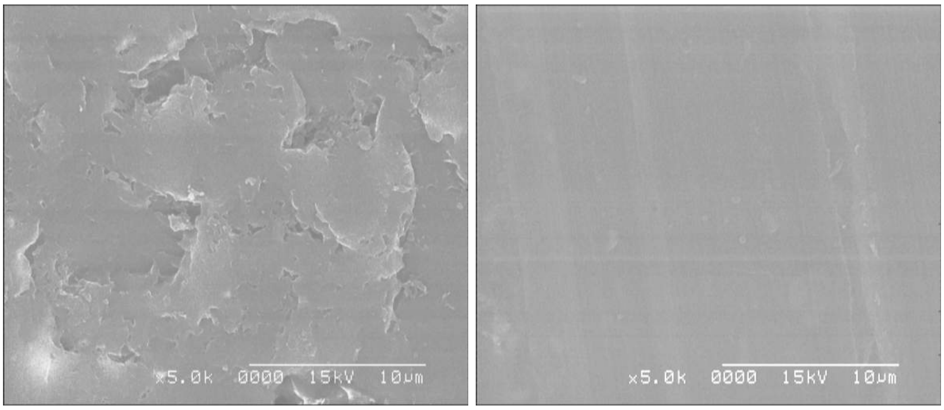

Figure 3. SEM image of the PMMA surface after the mild oxidation process and before the self-assembly process (left) SEM image of the PMMA surface after the self-assembly process (right).

In conclusion, the different polymer materials (PP, PP/EPDM, ABS and PMMA) were moulded by extrusion or injection process, in order to provide enough samples to develop the coating technology. To study the positive or negative effect of additives over the coating, some additives (UV stabilizers, colour masterbatches and fire retardant) from each polymer material and case study were selected. For that, the compounds were prepared and after that moulded to samples. It was concluded that the presence of additives also influenced in the design of the coating.

The two first stages of the coating process were developed and the SEM microscopy shows the success of the partial process.

WP3 – Development of co-deposition and precursor process of inorganic nanoparticles

In WP3 it has been studied the next steps from the self-assembly NANOSCRATCH process, the **hard nanoparticles deposition** and previously **nanoparticles modification**.

Nanoparticles modification: some of the selected inorganic nanoparticles to be linked to the self-assembly molecules have to be modified previously in order to activate functional groups. The technology used for this modification is the same than used for the preparation of immunoassays.

After the surface is prepared with the functional groups from the self-assembly process and the needed inorganic nanoparticles are modified, these nanoparticles are deposited to the surface linking the nanoparticles to the functional groups that are linked at the same time to the polymer surface.

Once bifunctional organic molecules have been linked to oxidized surface of plastics, nanoparticles must be deposited on that layer to obtain the final scratch resistant coating.

There are two ways to reach this goal: functionalizing different inorganic nanoparticles to make them compatible with bifuncional organic molecules or using nanoparticle precursors that precipitate on the surface creating a special coat, made by nanoparticles.

During self-assembly study, it was necessary to develop different treatments for the base materials: polymethyl methacrylate (PMMA), acrylonitrile butadiene styrene (ABS) and polypropylene (PP) because of their different nature and behaviour, the use of different self-assembly molecules with different bond types.

The modified nanoparticles with functional groups on their surface are co-deposited on the plastic, creating covalent bonds with the bifunctional organic molecules so the new coating will have a long self-life (Figure 4).

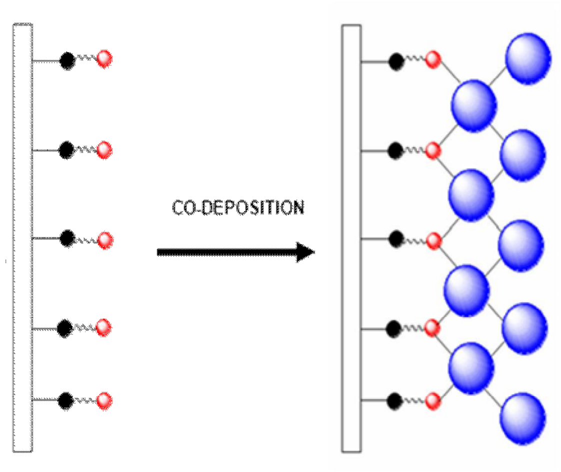

Figure 4: Scheme of the hard nanoparticles deposition process.

The deposition of nanoparticles can be made by two methodologies: by immersion or spray. Both treatments need a solvent to transport the nanoparticles until they link with the surface, such as water, ethanol, methanol or acetic acid.

To find the final treatment is necessary to pay attention to possible conditions of the process:

- What kind of plastic polymer.
- What type of functionalized nanoparticle:
- What solvent:
- Concentration of nanoparticles.
- Temperature of the solution.
- Method of application.
- Time of application.
- Temperature of drying.
- Time of drying.

Nanoparticle precursors is another method to develop the third stage of the process to obtain the final coat. Instead of synthesizing nanoparticles in an appropriate size and shape and functionalize them, it is possible to use these compounds that, when they are deposited on the surface, they are bonded among themselves generating nanoparticles and creating a three-dimensional network by chemical reaction. This methodology is easier and shorter than the method with functionalized nanoparticles but it is necessary to find the best conditions for the process.

Once the coating was optimised for each material, it was necessary to characterise them. The process was recurrent, in the sense that after a first series of pieces was coated, and tested, a second series was produced after optimisation of the coating in order to solve the adhesion and/or scratch problems of the different treated materials. Test methods used were scratch test, abrasion test and cross-cut test. Also visual inspection methods (naked eye and SEM) were employed.

Finally, the NANOSCRATCH coatings were compared to conventional coatings showing up to a 70% of improvement in scratch resistance. Figures 5 and 6 show pictures and anti-scratch results for untreated (P), NANOSCATCH treated (T), and conventionally coated (TC) samples, showing a significant improvement of the sample treated with NANOSCRACH coating over the other.

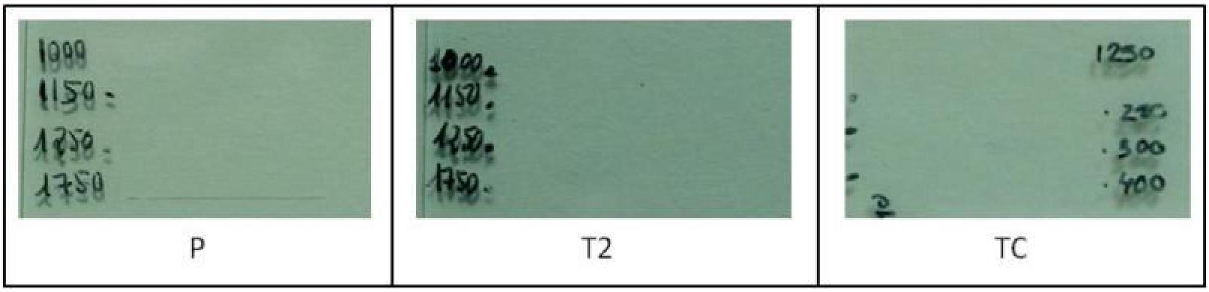

Figure 5: Images of the scratched samples from 1m on 90°

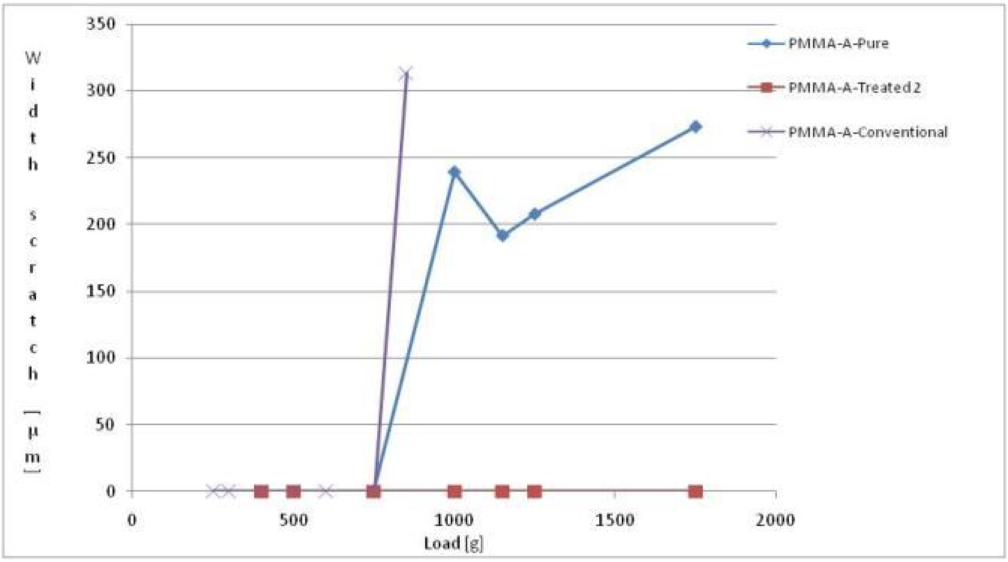

Figure 6: Results of scratch test.

WP4 – Case studies development at pilot plant level and industrial verification

The different industrial pieces corresponding to the case studies defines in WP1 have been manufactured in order to be treated with the NANOSCRATCH technology at pilot plant scale. Figure 7 shows pictures of three of the case studies.

Figure 7: Pictures of the case studies: ABS heater panel (left), and PP/EPDM cable test connector (right).

The pilot plant has been design and fabricated with tanks with 50 litres capacity. Once the pilot plant was installed, then it was monitorized in order to control the parameters needed to have a successful and controlled coating treatment.

After the pilot plant installation, the six different case study pieces have been coated (first the mild oxidation process and an after coating batch treatment) with the methodology developed in WP3.

In exception of the Door Panel of the car made in PP with talc, **all the case studies pieces have successful scratch resistance**, as the main objective of the project and defined in WP1 by end-users, when they are coated by the NANOSCRATCH coating process.

As it has been mentioned before, some other requirements including aesthetical evaluation have been defined by end-users in order to verify the final coated pieces. Some requirements as aesthetical surface, lifetime test or UV resistance for some case studies pieces **have been not totally achieved** by the final coating treatment because some coating treatments needs a specific optimization for concrete industrial pieces and some implementation problems must be solved in order to industrialise the treatment. Finally, 3 of the case studies complied with all the requirements defined in WP1.

An industrial evaluation and plant design has been carried out for the new coating process where there have been defined all the different equipment that it would be needed to implement the NANOSCRATCH technology to production lines.

A water treatment has been studied in order to identify what can be done with the cleaning water between the mild oxidation batch and the coating bath. As the water of the two tanks to wash plastic pieces does not have any nanoparticles, because this step is done before the coating treatment with silane compounds and nanoparticles, the water treatment is a purifying treatment used as a conventional physicochemical process to reduce its conductivity.

WP5 - Environmental, economic and regulatory studies

An analysis of the new material's recyclability have been carried out and it has been demonstrated that there is no negative influence of the NANOSCRATCH coating on their recyclability.

A Life Cycle Assessment has been carried out in order to compare conventional painting with the NANOSCRATCH treatment and the improvement is around a 10% over traditional treatments. Figure 8 shows the schematic of the NANOSCRATCH coating process considered for the LCA.

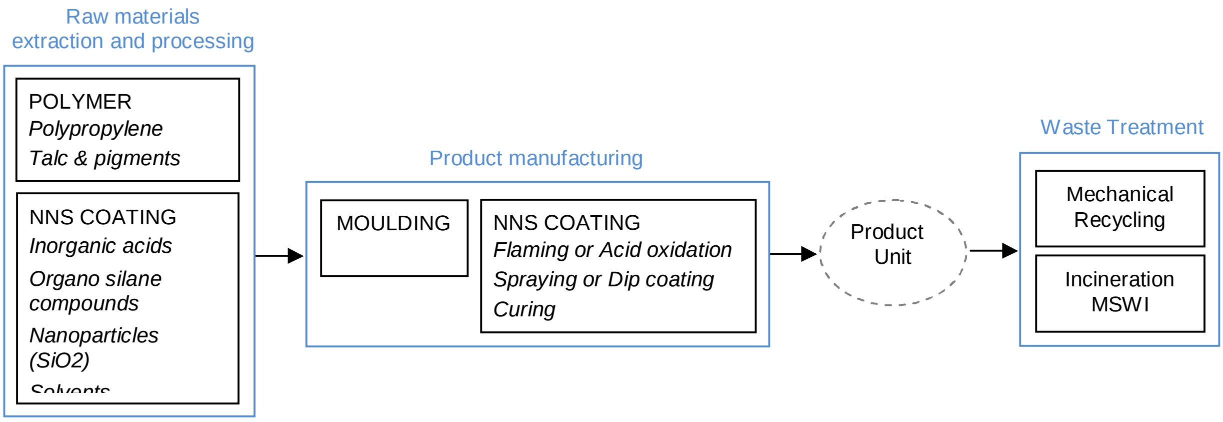

Figure 7: Life Cycle of NANOSCRATCH self assembly coating system.

A **Guide of Best practices** have been elaborated describing the best methodology for the NANOSCRATCH treatment, their safety issues and protections to work in this kind of process.

An economical analysis has been carried out taking into account the budget of the industrial plant studied in WP4, the materials costs and the rest of costs as human resources, maintenance, etc. All the case studies are economically viable when there is a material replacement.

A regulatory analysis of the different materials that have been used in the NANOSCRATCH treatments has been made, confirming that there are no problems to industrialise the NANOSCRATCH treatment provided that the usual handling precautions and safety considerations are implemented.

To sum up, the **main outcomes** of the project are:

- An environmentally friendly and profitable technology for treating the surface of plastic parts to increase the scratch resistance of plastic surfaces has been developed. Fundamental knowledge on the treatment of different plastic surfaces and the relationship between the polymer nature and the efficiency and composition of the different treatments has been generated, which has resulted in treatments tailored to the polymer matrix.
- Achieving a significant increase in anti-scratch properties of different polymeric materials: ABS, PMMA or PP/EPDM, increasing the application range in which they can be used.
- The coating technology has been scaled up at pilot-plant level, treating industrial samples. The industrial scale-up has been designed, showing that the costs of producing the different parts are cost-competitive with alternative technology, achieving cost savings up to 60% when there is material substitution. However, further developments are needed in order to effectively industrialise the technology, such as optimisation of coating by spraying in a continuous process.
- The industrialisation of the technology has been supported by Environmental studies (best technologies for the water treatment, analysis of material's recyclability, a Life Cycle Assessment), and a Regulatory analysis. A Guide of Best Practices has also been issued.

This new coating technology developed in the **NANOSCRATCH** project may have a significant impact on the plastic industry, provided that its current limitations are overcome, opening a wide range of applications. Although the project's development is aimed at the automotive sector and the white goods industry, the results of the project will be able to be applied to other diverse sectors, such as electronics in computers, DVD or in artificial ceramic surface plates, agriculture, packaged food transport, among others.

4. Potential impact and main dissemination activities and exploitation of results

Dissemination Activities

It is essential to highlight that several dissemination activities have been activated and completed during the development of NANOSCRATCH. The project information has been disseminated via three channels:

- By partners within their organizations (e.g. internal newsletters, meetings, workshops etc.)
- By partners during external events (e.g. fairs, presentations during leading composites & plastics fairs)
- By partners using media across Europe (e.g. press release, use of media partners, etc.)

The use of various channels (internal & external) and methods (written & online) assured an optimal contribution of coverage, visibility and most important- selling up the scene for better market acceptance in the near future.

The activities carried out as part of the Dissemination Plan are addressed different audiences and channels depending on the type of information to be disseminated, in order to assure the success of the project from a strategic, environmental, technologic and economic direction based on NANOSCRATCH approach.

Dissemination tools and activities could be divided in two main groups:

- **Industrial level:** For the SMEs, the principal objectives are to obtain results that will increase their competitiveness and market opportunities and to show these results to any potential client, in order to have a wider commercial activity and increase the company benefits. Activities such as participation in fairs, seminars, press releases…are aiming these results.
- **Non-commercial level:** The RTD participants of the project are more focussed in non-commercial, promoting and scientific aspects of the work. Only non-confidential project results are susceptible of publication or dissemination in journals, web-sites, congresses, workshops, fairs and seminars.

There have been no scientific publications related to NANOSCRATCH project due to commercial orientation of the Project results and the aims of the Consortium to protect and exploit the Foreground generated.

The dissemination actions for NANOSCRATCH project will obviously continue after the end of the project, mainly focused on the commercial audience, aiming the successful exploitation of the project results. Different Dissemination tools have been prepared, such as:

a. Online portal – Website: http://www.nanoscratch-project.eu
b. NANOSCRATCH Logo
c. Leaflet
d. Presentation of the project
e. Press release

All these resources are available at the Public part of the website and will be displayed in Fairs and meetings.

Potential Impact and Exploitation

The new technology developed in the NANOSCRATCH project may have a significant impact on the plastic industry; improving the current plastic properties and offering a greater range of applications. True industrial impact will require further developments, aimed to solve the difficulties found in the treatment of the pieces already at pilot-plant scale and optimising the treatments at industrial scale aiming to continuous fabrication processes.

Although the project's development is aimed at the automotive sector and the white goods industry, the results of the project will be able to be applied to other diverse sectors, such as electronics in computers, DVD or in artificial ceramic surface plates, agriculture (greenhouses), furniture, conveyor belts (packaged food transportation), provided that the specific requirements of each application sector can be fulfilled.

In that sense, NANOSCRATCH consortium is already engaged in commercial activities in order to exploit the 4 main results (Foreground) that have been achieved:

Result 1. New scratch coating technology for transparent plastic parts.

Result 2. New scratch coating technology for non-transparent plastic parts.

Result 3. Monitorization

Result 4. Nanoparticles synthesis or modification.

Protection of these results has been initiated by the Consortium. An **exploitation agreement** has been included as part of the Plan for Using and Disseminating the Foreground, identifying Results owners and co-owners, defining the IP protection means and establishing the preferential conditions applicable to the participant End-Users.

5. Website and contact details

The NANOSCRATCH website, **http://www.nanoscratch-project.eu/**, was published at the beginning of the project. This dissemination resource is directed to a varied audience: the public at large (industry stakeholders, academia, EU and national officials, etc) and/or the beneficiaries involved in the project, the consortium.

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