Final Report

Project acronym: *WABASELCOAT*
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M-ERA.NET Call 20*16*

Period covered: 01/06/2017 to 30/05/2020

2. Publishable project summary

Wabaselcoat project activities for 36 months were carried out in the framework of WP0, WP1, WP2, WP3, WP4 and WP5.
Within WP1, we studied the structures and thermal emissivity of various water-borne binders. The study included commercially available binders, 13 single-component binders and one binary component. In addition to binder studies, the properties of various commercially available metallic pigments were studied to select the Al-flask with the lowest thermal emissivity. The study included various flakes suitable for water-based coatings as well as solvents for solvent-based coatings. Moreover, intending to improve the solar absorption and corrosion protection of metallic pigments we incorporated various MWCNTs and 2D carbon nanomaterials, such as platelets graphene and graphene nano-ribbons in Thickness Insensitive Spectrally Selective absorber paints. Reasonable selection of the binder, metallic flakes and carbon-based materials based on facts extracted from work in WP1 resulted as solid ground for formulation of water-based Thickness Insensitive Spectrally Selective (TISS) absorber coatings.
In WP2, most of the time was devoted to the development of various additives, among which the synthesis of various POSS molecules with low surface energy, as well as the synthesis of POSS molecules with one of the eight side groups on the polyhedral structure modified by the ionic side group, which are studied in the context of surfactants for the preparation of micelles in WP2. Most of the work was devoted to the synthesis of hollow spheres from siloxanes, and full SiO_2 beads. Hollow beads are used as a vehicle for the integration of molecules with low free surface energy or self-healing molecules into the coating structure. Moreover, in WP2 carried out the synthesis of flame-retardant additives for polymeric binders was performed. Flame retardant additives thus provide greater safety in the use of water-based coatings. With the synthesis and incorporation of fluoro-isooctyl amino based POSS molecules, we achieve sliding high sliding angles for water (>130°) and hexadecane (>90°) in used binders for the formulation of TISS paints. Furthermore, synthesised amphiphilic POSS molecules can be used also as additives for improving the efficiency of Dye synthesized solar cells.
In WP3 we were active in formulating water-based TISS coating with the black and coloured hue (red and blue). Prepared formulations were tested on PPS substrates with pre-treatment, developed in WP4. We focused on the sandblasting of substrates, which allowed lower free surface energy, greater roughness, resulting in better coating adhesion and cohesion. Work was focused on pigment concentration, milling procedure, pigment modification, pot-life, rheology tuning and spray application. All those factors are reflected in the optical properties of the coatings. Final formulations are UV, thermal and mechanically stable. Coloured water-based TISS coatings assign in addition to increased solar energy transformation efficiency also visual attractiveness when bluish and reddish coloured hue replace the black coating
The methodology used in WP4 based on trials and errors as we need to develop the guidelines for substrate cleaning and activation, application of water-borne paints, optimization of spraying conditions in parallel with testing. According to research results, the most appropriate way to clean the extruded surface for the application of water-based TISS paints is sandblasting, as it is fast, price competitive and with low impact on the environment. In the case of solvent cleaning large amounts of volatile organic compounds are released in the atmosphere in contrast to plasma cleaning where surface activation should be performed just before the application of the paint. In those two cases, surface roughness is less modified and therefore decreased adhesion is observed. In correlation with paint application rheology of the paint was optimised to get improved optical properties. Our study aimed to determine the influence of spraying parameters (nozzle, spray gun pressure, and speed of substrate) on the selectivity and to establish the phenomenon of pigment distribution and flake orientation during spraying application. Different amounts of solvent were added to the initial paint and the diluted paints were examined with the same rheological tests.
Finally, in WP5 most of the work was devoted to the development of testing infrastructure and durability testing. Results disclose that absorbers developed in the Wabasel project, are reliable, durable and more efficient than solar thermal flat plate and evacuated tube collectors at above ambient temperatures.