Rijksdienst voor Ondernemend Nederland

Public final report Anti-soiling And PV (ASAP)

Project data

- Project number: TEHE116003
- Title: Anti-soiling And PV (ASAP)
- Coordinator and partners:
    - TNO (coordinator)
    - Rebor B.V.
    - DSM Advanced Surfaces
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Summary of starting points, aim and collaborating parties

The project Anti-soiling And PV (ASAP) was initiated by TNO, DSM and Rebor B.V. with the aim to study the effects of anti-soiling coatings on the power output of PV panels in an environment prone to soiling in The Netherlands.

Already a market leader in anti-reflective coatings for solar photo-voltaic (PV) applications, DSM has begun the development of anti-soiling coatings. TNO has developed dedicated testing methods to evaluate the properties of these coatings for PV applications. And Rebor B.V. together with TNO have designed and built a field test setup for testing coatings on PV panels under field conditions.

Description of the project results, bottlenecks and perspective of application

Soiling of photovoltaic (PV) solar panels is a potential cause of yield losses, related to decreased light transmission of the front glass and resulting in lower current and lower electrical power generated. Although the problem obviously relates to dry desert type environments it can also occur in moderate climate zones. Regular cleaning of PV systems is often advised to mitigate the effects of soiling, however depending on system size and location this can add significantly to the operation and maintenance costs. As alternative to cleaning also passive mitigation methods exist, of which dirt repelling coatings have rapidly gained attention. These so-called anti-soiling coatings intend to prevent dust and dirt particles from adhering to the surface on which these coatings are present. Although anti-soiling coatings can be based on widely different chemical compositions, they can be classified in general into two fundamentally different types, characterized as hydrophilic and hydrophobic. Hydrophilic coatings fundamentally differ from hydrophobic coatings regarding their behavior towards water. The first type attracts water, resulting in formation of a very thin homogeneously spread water film on a coated substrate. The intention is to effectively wash away all dirt by this water film. The latter one repels water, resulting in formation of droplets, easily rolling off the substate and taking along the dirt present.
Within the project a laboratory test sequence has been developed to determine the performance and durability of anti-soiling coatings. Standard PV testing protocols (e.g. IEC 61215) need to be passed by PV panels and any coating present on them, this addresses the influence of several weathering factors like temperature changes and moisture levels. The influence of mechanical wear, by e.g. washing, affecting the usually very thin coatings is not addressed by the standard PV testing protocols. A standard on abrasion of thin coatings on glass (NEN-EN_1096-2) addresses the influence of abrasion on the transmission of coated glass. This standard has been combined with a newly developed test protocol for artificial accelerated soiling under laboratory conditions to study the influence of mechanical wear on coating properties. The combined test has been used to make a ranking of coatings regarding anti-soiling performance and resistance towards abrasion. It appeared that the abrasion resistance can vary substantially (more than a factor 10), comparing different types of anti-soiling coatings. This emphasizes the relevance of the laboratory test developed for the evaluation of coating performance and durability. It should be noted here that any coating intended to be applied to the front glass of PV panels should at least have an outstanding performance regarding light transmission. In that respect anti-reflective coatings (AR) developed for PV applications are the best option since they are very thin, very transparent and substantially suppress the reflection of light from the front glass plate. In this way they enable a higher power output compared to uncoated glass. Since the application of AR coatings for PV has become standard it means that any new feature added by an additional coating should not affect the AR coating performance. In practice this means that anti-reflective and anti-soiling properties need to be combined into one single coating. Project partner DSM has focused on the development of such combined AR-AS coatings for PV applications.

The results of abrasion and artificial soiling testing in the laboratory for the coatings provided by DSM were positive: After abrasion only a minor loss in anti-soiling activity and anti-reflectivity has been observed and the tested coatings still revealed substantially better performance in both aspects than uncoated glass. After successful laboratory testing of a number of anti-soiling coatings the best performing coatings (also featuring anti-reflective properties) have been selected for further testing in a field test under relatively dust rich conditions on a farm roof in the province of Noord Brabant. A number of PV panels have been coated by DSM with an AR and AR-AS combined coating respectively to be field monitored during an extended period of time (i.e. at least one year). Together with uncoated reference PV panels these coated panels have been installed on a roof and the power output is being monitored.

The main result after 1,5 year of field measurements is that for this specific site, although expected to be relatively dust rich, no measurable soiling occurred on the monitored PV system. Soiling has been observed on this site, but only on the surface close to a dust emitting ventilation exhaust (within a few m^2) and not on the monitored PV system intended for observing that. These observations indicate that soiling in the Dutch climate is not a commonly occurring issue but can be a very site specific and localized problem.

Finally the economic aspects of anti-soiling coatings under different soiling scenarios have been studied by means of a techno-financial analysis. Business case calculations indicate that it is economically viable to have PV panels coated with a combined antireflective/anti-soiling coating to make them fit to dust rich environments no matter where they are installed. The coatings have an added value, even in regions with clean air where soiling levels are low.

In the end the glass manufacturers determine which coatings are deposited onto the glass applied for PV panels and it is most convenient if they can sell one type of coating on all glass they supply to PV panel manufacturers. From this consideration it follows that the best perspective for application to PV panels is to replace the currently applied anti-reflective coatings entirely by the combined anti-soiling/anti-reflective coatings, creating a maximum applicability for these coated PV panels.

Description of the project contribution to the aims of the program (renewable energy, improved knowledge position)

The project has resulted in an increase of knowledge on anti-soiling coatings and a new testing method for evaluation of coating performance. The project has demonstrated that combined anti-soiling/anti-reflective coatings can contribute to a higher energy generation of PV systems in an economical way. The combined coating performs as well as just an anti-reflective coating in terms of peak power and at the same time mitigates the adverse effects of dust. This enables a higher net electricity generation for PV systems installed at locations suffering from air pollution or dust.

Overview of publications concerning this project

- Testing anti-soiling coatings for PV, P.M. Sommeling, poster presentation during the 2017 International Soiling Workshop, Oct 23-25th 2017, Dubai

- Business cases for anti-soiling coatings in The Netherlands, C. Tzikas, M. Cappa, M.N. van den Donker, P.M. Sommeling, G.P.J. Verbong, W. Folkerts, Proceedings of the 35th European Photovoltaic Solar Energy Conference and Exhibition, p. 1519 – 1522 (2018)

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Contact for additional information

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