PPS-jaarrapportage 2018
De PPS-en die van start zijn gegaan onder aansturing van de topsectoren dienen jaarlijks te rapporteren over de inhoudelijke en financiële voortgang. Voor de inhoudelijke voortgang dient dit format gebruikt te worden. Voor PPS-en die in 2018 zijn afgerond is een apart format "PPS-eindrapportage" beschikbaar.
De jaarrapportages worden integraal gepubliceerd op de websites van de TKI's/ topsector. Zorg er s.v.p. voor dat er geen vertrouwelijke zaken in de rapportage staat.
De PPS-jaarrapportages dienen voor 1 maart 2019 te worden aangeleverd bij de TKI's via info@tkitu.nl of info@tki-agrifood.nl. Voor Wageningen Research loopt de aanlevering via een centraal punt.

Algemene gegevens	
PPS-nummer	KV 1604-037
Titel	PPS Smart Materials
Thema	Energie & CO2
Uitvoerende kennisinstelling(en)	WUR, Stichting Wageningen Research
Projectleider onderzoek (naam + emailadres)	Silke Hemming, silke.hemming@wur.nl
Penvoerder (namens private partijen)	Marcel van Haren, Vereniging FME-CWM
Contactpersoon overheid	Leo Oprel
Totale projectomvang (k€)	M€1.44
Adres projectwebsite	www.ppssmartmaterials.nl
Startdatum	1/1/2017
Einddatum	31/12/2020

Goedkeuring penvoerder/consortium De jaarrapportage dient te worden besproken met de penvoerder/het consortium. De TKI's nemen graag kennis van eventuele opmerkingen over de jaarrapportage.	
De penvoerder heeft namens het consortium de jaarrapportage	x goedgekeurd □ niet goedgekeurd
Eventuele opmerkingen over de jaarrapportage:	

Planning en voortgang (indien er wijzigingen zijn t.o.v. het projectplan svp toelichten)	
Loopt de PPS volgens planning?	**ja**
Zijn er wijzigingen in het consortium/de projectpartners?	**nee**
Is er sprake van vertraging en/of uitgestelde opleverdatum?	**nee**
Is er sprake van inhoudelijke knelpunten, geef een korte beschrijving	**nee**
Is er sprake van afwijkingen van het ingezette budget/de begroting?	**nee**

Korte omschrijving inhoud/doel PPS Wat is er aan de hand en wat doet het project daaraan? Wat gaat het project opleveren en wat is het effect hiervan?
The **demand for vegetables and fruits worldwide is increasing**. Vegetables and fruits for fresh consumptions are produced in protected cultivation. With increasing affluence, the area

of protected cultivation in the world is increasing, leading to increased demand for fresh, high-quality vegetables, without chemical residues. Protected cultivation in greenhouses makes this possible by capturing the sun's energy to raise inside temperature. Several properties of the cover materials contribute to crop productivity, quality and even the content of healthy compounds. The amount of sun radiation entering the greenhouse determines its temperature; light in the PAR wavelength range drives photosynthesis, the fundamental motor of crop production; the wavelength composition of light has a "signalling effect" on crop development and on the content of nutraceuticals of food products and the geometrical distribution of light affects crop productivity. In addition, the properties of the cover (and additional screen) material(s) determine the energy that is lost at night, requiring replacement by heating.

There is a great need and a huge potential for the development and application of **"smart" or "adaptable"** cover **materials** that would make it possible to control the quantity, spectral composition and geometrical distribution of solar radiation entering the greenhouse. Next to light and temperature, a smart control of the growth factors CO_2 and humidity is very important to optimize crop production and nutritional food products. New selective membranes and other "smart" or "adaptable" materials are needed so that a microclimate and light environment is generated that maximizes food production and desired quality aspects and containing healthy components, while minimizing/nullifying the need for fossil energy. This program will benefit from a two pronged approach: the adaptation of existing knowledge and materials to solve horticultural challenges, but also new higher-risk/higher-reward research to solve these challenges.

The **long-term goal** is that new greenhouse production systems will utilize sunlight in a very efficient way since they will be covered with smart or adaptable materials. Solar light at any climate zone in the world will be converted into a form (quantity, quality, geometrical distribution) exactly needed by the crop to produce fresh products with high yield, good taste and high in healthy components. All growth factors (light, temperature, CO_2, humidity) will be controlled by smart or adaptable materials in order to reach a minimum input of resources during food production (energy, CO_2, water).

In this program we focus as well on **fundamental research** for new smart material development as **on industrial research** of modification of existing materials and implementing adapted materials in greenhouse production systems. Short-term product screening and testing is combined with mid-term material adaptation and long-term fundamental new smart material development.

The program is a **cross over of TKI TU and HTSM** (High-tech 2 Feed the World) and offers a unique collaboration of horticultural supply industry with high-tech industry, as well as a unique collaboration between academic researchers in the areas of horticulture and chemistry to design new greenhouse production concepts with smart materials for the horticultural industry that could be applied on a huge scale.

The Dutch horticultural sector will profit from knowledge brought in from the international high-tech industry and will benefit from the knowledge and new products developed in this program. At the same time the visibility of the Dutch greenhouse horticulture as a high-tech production sector is directly enlarged.

Resultaten 2018

Geef een korte beschrijving van de high-lights van 2018
Geef een korte beschrijving van de projectdeliverables 2018

During the second year of the project different smart materials have been developed by project partners and were tested at WUR LightLab. Topics for material development are e.g. light transmittance, light diffusion, high insulation with new technologies, new polymers, new insect and shading netting technologies, heat reflection, humidity control by foils, membranes and coatings, materials with switchable properties triggered by temperature or electrical. Application fields are greenhouse systems world-wide depending on the innovation. Targeting crops are high-value food crops and ornamentals.

Prototype materials from project partners have been investigated by WUR on their optical and physical properties (hemispherical light transmission, light spectrum, light scattering patterns, condensation behavior, thermal properties and porosity). Measured properties have then been used for greenhouse climate and crop growth simulations in order to predict the materials' effect on different crops, greenhouse types and climate zones. From the simulation outcome potential business cases have been built and shared with project partners. Suggestions for further material development were made.

A first stage of a market study has been finished providing project partners with insights in potential markets for the (future) smart materials products.
First small-scale experiments have been started on new types of highly diffusing materials and on light switching materials. However, experiments are ongoing, results not yet available. New small-scale experiments are planned on humidity control and anti-bacterial properties.
A workshop on light spectrum has been held in Bleiswijk area with field visits to Ter Laak orchids and Anthura to learn on detailed needs of different commercial greenhouse crops.
Networking of different partners played an important role in the project. A matchmaking event has been organized between project partners which led to new ideas for co-creation. First co-creation projects have been started.
The half-yearly project meetings took place in the DomoLab, Saint-Gobain, Paris and the Innovation Centre of BASF, Ludwigshafen.
TU/e has developed switchable materials triggered on an electric voltage and on temperature change. A description of these materials is published in scientific journals.
Growers might expect new ways of controlling the crop environment in the future.

Aantal opgeleverde producten in 2018 (geef in een bijlage de titels en/of omschrijvingen van de producten of een link naar de producten op de projectwebsite of andere openbare websites)

Wetenschappelijke artikelen	Poster	Rapporten	Artikelen in vakbladen	Inleidingen/workshops
2	1	2		3

Titels/omschrijvingen van belangrijkste producten in 2018 (max. 5) en hun doelgroepen

Doelgroep: Onderzoekers
Sol, J. A. H. P., Timmermans, G. H., van Breugel, A. J., Schenning, A. P. H. J. & Debije, M. G., 2018, Multistate luminescent solar concentrator 'smart' windows, In: Advanced Energy Materials. 8, 12, 8 blz., 1702922
Sol, J. A. H. P., Dehm, V., Hecht, R., Würthner, F., Schenning, A. P. H. J. & Debije, M. G., Temperature-responsive luminescent solar concentrators: tuning energy transfer in a liquid crystalline matrix, 22 jan 2018, In : Angewandte Chemie - International Edition. 57, 4, blz. 1030-1033

Doelgroep telers:
Hemming, S., 2018, Smart Materials. Poster, Energiek Event, Bleiswijk, The Netherlands, 5 April 2018 (pdf)

Doelgroep toeleveranciers:
www.ppssmartmaterials.nl

Bijlage: Titels/omschrijvingen van alle producten in 2018 of een link naar deze producten op de projectwebsite of andere publieke websites

Website:
www.ppssmartmaterials.nl

Nieuwsitems:
https://www.kasalsenergiebron.nl/onderzoeken/e16025_smart_materials_for_greenhouses/

Wetenschappelijke artikelen (now published on paper):
Sol, J. A. H. P., Timmermans, G. H., van Breugel, A. J., Schenning, A. P. H. J. & Debije, M. G., 2018, Multistate luminescent solar concentrator 'smart' windows, In: Advanced Energy Materials. 8, 12, 8 blz., 1702922
Sol, J. A. H. P., Dehm, V., Hecht, R., Würthner, F., Schenning, A. P. H. J. & Debije, M. G., Temperature-responsive luminescent solar concentrators: tuning energy transfer in a liquid crystalline matrix, 22 jan 2018, In : Angewandte Chemie - International Edition. 57, 4, blz. 1030-1033

Poster:
Hemming, S., 2018, Smart Materials. Poster, Energiek Event, Bleiswijk, The Netherlands, 5 April 2018.

Rapporten:
Baeza-Romero, E.J.; Breugel, B. van; Swinkels, G.L.A.M.; Hemming, S.; Stanghellini, C., 2018, The perfectly smart greenhouse cover: a simulation study. WUR report WPR-776, p. 100. (confidential until 1/1/2021).
Ruijs, M. 2018, The global market size of greenhouse production, market trends and developments, WUR report Wageningen Economic Research 2018-113C, p. 28. (confidential until 1/1/2021).