Fabrication and evaluation of a nickel shim for large-area hot embossing of plant surface structures

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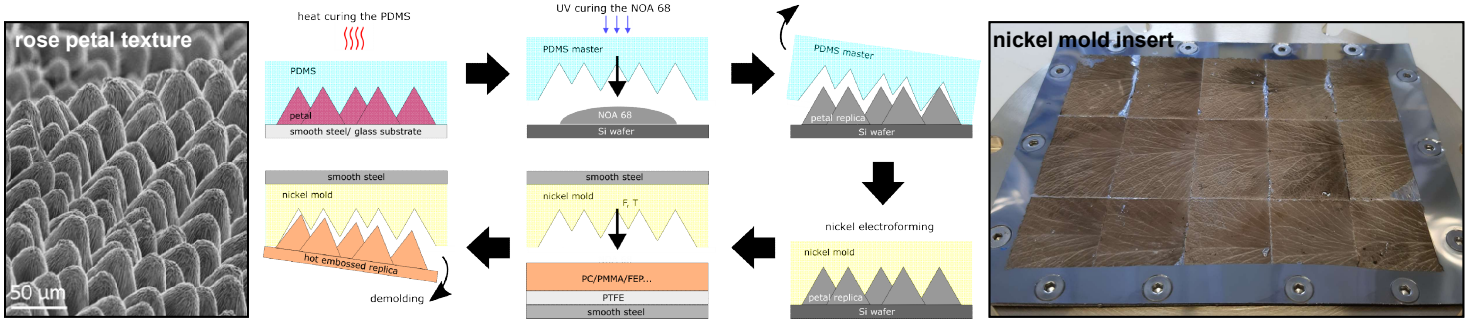
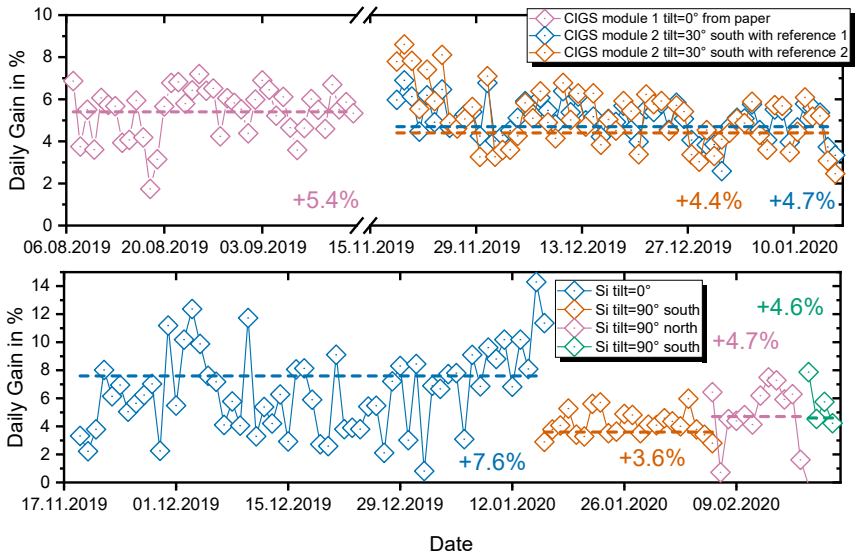
1. Motivation – bioreplicated surface textures as multifunctional solar cell cover layers

Petal textures exhibit outstanding broadband and omnidirectional **light harvesting** properties on solar cells [1,2] + by choice of low surface energy materials their **self-cleaning** properties can be harnessed [3].
A hot embossing routine via robust nickel embossing tools has been developed for a large area fabrication of such textures.



2. Outdoor performance of polymeric hot embossed petal textures on solar modules

Outdoor performance monitoring under various module orientations.



3. Product Development

Product	SGG Albarino T	SGG Albarino P	TitanShield	DSM ARC	DSM Self Cleaning	DSM ARC XT	fleurface
Technology	Lightly textured glass	Deeply textured glass	TiO_2 und SiO_2 nanoparticles	Core-Shell nanoparticles	Core-Shell nanoparticles	Core-Shell nanoparticles	Rose textured polymer foil
Gain (optimal tilt)	-	~ 3 %	~ 3 %	~ 3 %	~ 3 %	~ 4 %	**5 – 7 %**
Angular tolerance	−	○	−	−	−	−	+
Broadband	−	○	−	−	−	○	+
Anti-Glare	−	○	−	−	−	−	+
Light-Trapping	−	+	−	−	−	−	+
Self-cleaning	−	−	+	−	+	−	+
Aesthetics	−	○	−	−	−	−	+

fleurface

Start-Up in preparation:

- Further uspcaling of textured area, patent pending.
- Establishing continuous embossing process
- Targeting building integrated PV as entrance market

[1] R. Hünig, A. Mertens et al. Flower Power: Exploiting Plants' Epidermal Structures for Enhanced Light Harvesting in Thin-Film Solar Cells. Adv. Opt. Mater. 2016
[2] B. Fritz et al. Assessing the influence of structural disorder on the plant epidermal cells' optical properties: a numerical analysis. Bioinspir. Biomim. 12 036011, 2017
[3] B. Fritz et al. Towards mass fabrication of hot embossed plant surface texture replicas as photovoltaic cover layers. SPIE Nanoscience + Engineering, doi:10.1117/12.2320555, 2018