

## PERDRY

### Dry production routes for large-area benign metal halide perovskite solar cells

*Project duration: from 11.2019 to 12.2022*  
*Report submitted: 07.2020*

#### **Publishable Summary**

Solar cells employing metal halide perovskite, HaP, light absorbers have developed tremendously over the past years. So far, best efficiencies (>22%) were all obtained with lead-based HaPs, prepared by non-scalable spin-coating using often toxic solvents. Hence, to reach a TRL >5 it is essential to develop scalable processes with no toxic solvents and either replace the lead or ensure safe “end-of-life” protocols. We will use dry processing to prepare uniform large-area and benign HaP thin films and integrate them into efficient photovoltaic devices. Physical vapour-based processes such as co-evaporation, flash evaporation and pulsed laser deposition of the binary constituents or pre-formed powders will be used. The current TRL of these processes is 3-4 for flash and co-evaporation and 2 for pulsed laser deposition. The main benefit of these dry processes is that they are solvent-free and additive (allowing for multiple layer films). They allow for a very high compositional freedom, because no common solvent is needed to process/dissolve the precursor salts. Furthermore, control over the numerous interfaces in the stacked layer device is less problematic than for solution-based addition of layers. We will leverage this important advantage to develop more benign HaP films, by replacing toxic lead with tin, bismuth, or antimony and a mono-valent cation. Our Solar Cell manufacturing partner, 3GSolar, will provide the consortium with end-user information and with knowledge regarding rigorous encapsulation. The latter will prevent contact of the perovskite with ambient atmosphere, which strongly increases the lifetime and eliminates risk of lead contamination to the environment. To demonstrate TRL=5 partner Solmates will prepare 10 by 10 cm films using vapour-based processes and integrate them into solar cell demonstrators (PCE>19%, and stability over 5000 hours).

#### **Project consortium**

Coordinator and all contact details:

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Participating countries and financing:

Country	Number of organisations involved	Project costs in EUR	Public funding in EUR
Spain	1	183'700	173'500
Israel	2	496'885	387'129
The Netherlands	1	48'000	0
Sweden	3	471'683	331'650
<i>Total</i>	9	<i>1'152'268</i>	<i>892'279</i>

### Funding agencies involved and contracts

Funding Agency	Contract N° and Title
Ministerio de ciencia e innovación- Agencia Estatal de Investigación	PCI2019-111829-2 Producción en seco para celdas solares basadas en perovskitas usando haluros metálicos benignos
Israel Min. of Energy & Infrastructure	219-11-119 Exploring Ways to Large-Area Halide Perovskite-Based Photovoltaics
In-kind	-
Energimyndigheten (StEM)	P48381-1 Torra produktionsvägar för storskaliga perovskitsolceller
Swedish energy agency	2019-004603 P48381-1
Energimyndigheten	P48381-1
Ministry of Energy	219-11-081