New efficient encapsulation methods to improve the environmental stability in efficient perovskite solar cells.

F. Javier RAMOS,1,2* Amelle REBAI,1,2 Sophie BERNARD,2,3 Sebastien JUTTEAU,2,3 Nathanaelle SCHNEIDER,1,2 Tony MAINDRON,4 Thomas GUILLEMET,2 Nicolas LOONES,2,3 Cédric BROUSSILLOU,5 Gilles GOAER,5 Jean ROUSSET1,2,3

1 IPVF, Institut Photovoltaïque d’Ile-de-France, Palaiseau, France. 2 IRDEP, Institute of Research and Development for Photovoltaic Energy, CNRS-EDF Chimie ParisTech, Chatou, France. 3 EDF R&D, Chatou, France. 4 CEA Leti Grenoble, France. 5 Photowatt, Bourgoin-Jallieu, France
* Email: javier.mellado@ipvf.fr

Perovskite solar cells (PSC) have emerged during the last five years as one of the PV technologies with more brilliant future due to their versatility and exceptional optical and electrical properties. In spite of the remarkable results pushing the efficiencies > 22%, some important aspects for their future commercialization have remained less explored. For instance, although some approaches of encapsulation systems can be found in literature, a final solution providing long term stability is still needed.

In this work we report two encapsulation processes showing much higher long-term stability in terms of performance than the referential non-encapsulated cells (Figure 1). The first system consists of an ultrathin Al₂O₃ film made by Atomic Layer Deposition (ALD) while the second is an industrial process using a polymeric film commercially available. A detailed study about evolution of electrical and photovoltaic properties in both systems will be presented. In brief, encapsulated devices showed outstanding improved properties under ambient conditions in comparison with non-encapsulated ones employed here as reference since neither perovskite nor Spiro-OMeTAD degradation was observed for both encapsulation methods.

![Figure 1](image-url)

*References*