Complementary Imaging Techniques for Tracking Degradation of Flexible Encapsulated Organic Photovoltaic Devices Along Processing and Ageing

Sacha Juillard[a,b,c,d], Emilie Planès[a,b,c], Muriel Matheron[b,d], Solenn Berson[b,d], Lionel Flandin[a,b,c]

[a] Université Savoie Mont Blanc, LEPMI, F-73000 Chambéry Cedex

[b] Univ. Grenoble Alpes, INES, F-73375 Le Bourget du Lac, France

[c] CNRS, LEPMI, F-38000 Grenoble Cedex

[d] CEA, LITEN, Department of Solar Technologies, F-73375 Le Bourget du Lac, France

Despite steadily increasing efficiencies, the lifetime of organic photovoltaic (OPV) devices is still a major issue that has to be overcome to prove their industrial interest. In order to delay their degradation by water and oxygen, the flexible devices are encapsulated between gas-barrier films.

However, there is a lack of feedback about the influence of the encapsulation processes and materials on the immediate and long-term performances of the devices. In fact, in most publications about devices ageing, the encapsulation process is not described or not even mentioned [1].

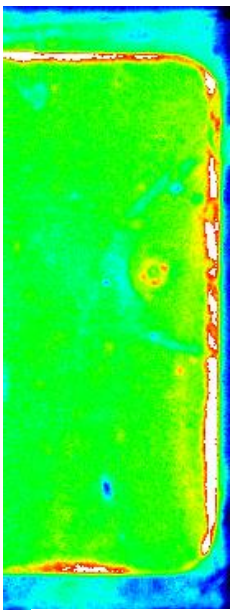
Due to the localized permeation of harmful species through the encapsulation during ageing, I(V) curves can only supply overall information on the device current state.

Complementary imaging characterizations can be employed in order to track the localized degradation of encapsulated devices during their processing and ageing.

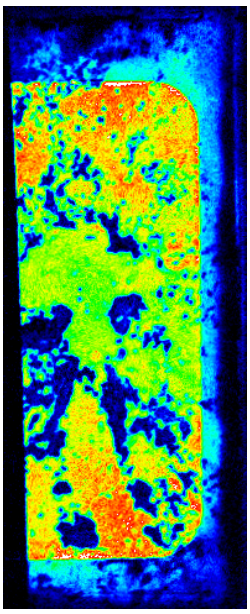
Luminescence imaging, lock-in thermography and Laser Beam Induced Current techniques were employed before and after encapsulation as well as during ageing under controlled temperature and relative humidity (RH) conditions. These methods were used to track local variations of series resistances, formations of shorts, delaminations and losses of conjugation in the active layer across the whole devices surface. Additionally, the adhesion between the layers composing the devices was studied as a parameter influencing the devices performances during processing and ageing as well.

The aim of this work is to establish a link between the devices cohesion, the encapsulation process and the ageing of flexible devices.

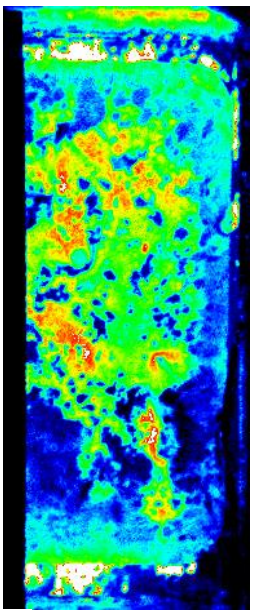
[1] Gevorgyan *et al.*, "*Lifetime and of Organic and Photovoltaics: Status and Predictions*" Adv. Energy. Mater., **2016**, 6, 1501208



Fresh cell



Fresh cell after encapsulation



Encapsulated cell after aging at 85°C/85%RH

Biased photoluminescence images mapping the current extraction of OPV cells (left) before encapsulation, (center) after encapsulation, (right) after encapsulation and aging at 85°C/85%RH.

The encapsulation process has a deleterious effect on the cell current extraction homogeneity. Further water ingress during aging gradually decreases cell performance as well.

The Images are scaled arbitrarily.