Novel apparatus for electronic transport measurements of semiconductor thin films: Minority carrier diffusion length and photo-conductivity

M. Elyaakoubi[1], J. Meot[1], C. Longeaud[2]

[1] TFSC-Instrument, 3 Rue Léon Blum, 91120 Palaiseau, France

[2] GEEPS-CNRS/ CENTRALE-SUPELEC, 11 rue Joliot Curie, 91190 Gif sur Yvette, France

Thin film semiconductors are widely used in Photovoltaic application in order to improve its competiveness taking advantage of their ability to reduce drastically the production price of solar modules. However the material quality, when inserted in solar cell device, is not yet ready to achieve energy conversion efficiency high enough to compete with crystalline solar cells in production industry. Recently new materials are emerging and present very encouraging results such as organics solar cells showing more than 10% module efficiency and such as perovskite showing more than 20% as initial efficiency. Nevertheless, more research is needed to improve the maturity of such technologies and to succeed to bring the thin film photovoltaic modules as a serious alternative to other energy sources from the point of view for the watt-peak cost.

The instrument developed by TFSC-Instrument SAS, in collaboration with GEEPS, is dedicated to semi-conductor thin films and based on an innovative way to measure the diffusion length of minority carrier by SSPG (Steady State photocarrier Grating); This instrument is fast, reliable and easy to use and hence accessible to non-specialized researchers or engineers (see basic principle on figure 1). The instrument is also able to access to SSPC (Steady state Photo-Conductivity) data such as dark conductivity and photo-conductivity for various illumination conditions and for various sample temperatures from which one can deduce the material activation energy, for instance, giving access to a complete basic electronic characterization of the studied photoconductive material.

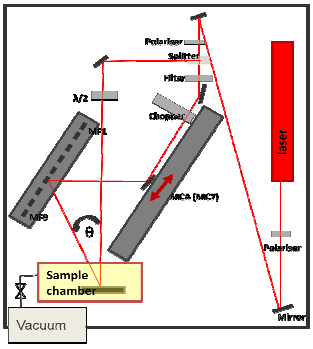

Figure 1

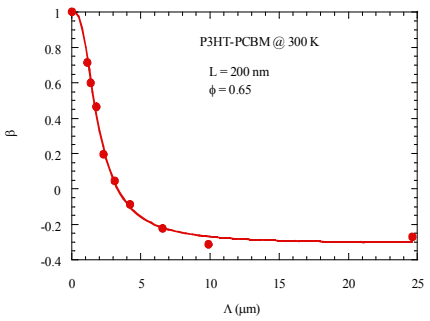

Figure2

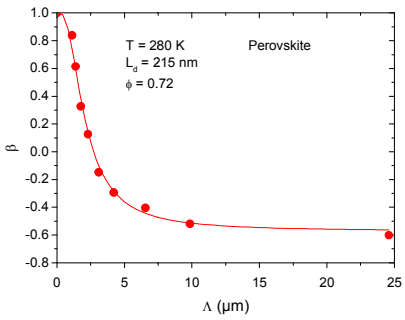

Figure 3

Though it is difficult to access easily to transport properties of thin films by the conventional methods of measuring the mobility and the life-time separately, the SSPG method has been successfully applied to the organic based Bulk-Hetero-Junction, namely P3HT:PCBM (see figure2). It has been also applied successfully to the promising perovskite material (see figure 3).

These results demonstrate that this characterization tool, and particularly the SSPG method, can be applied to organic and non-organic thin film materials and consequently can contribute to the fast emergence of new generation of solar cells having high efficiency and low production cost that will be attractive to the energy market.