Macro-scale contactless characterisation of graphene-based transparent electrodes

S. Fernández[1], J.J. Gandía[1], A. Inés[2], I. Arnedo[2], M. de la Cruz[1], A. Boscá[3], J. Pedrós[3], M. A. Pampillón[3], A. Molinero[1], M.B. Gómez-Mancebo[1], F. Calle[3], J. Cárabe[1], J. Martínez[3], I. Rucandio[1]

[1]*CIEMAT, Avda. Complutense, Madrid 28040, Spain*
[2]*Das-Nano, Polígono Industrial Talluntxe, Tajonar, 31192 Navarra, Spain*
[3]*ISOM (ETSIT-UPM), Ciudad Universitaria, Madrid 28040, Spain*

susanamaria.fernandez@ciemat.es

Graphene is attracting a huge interest as promising candidate for the next generation of transparent electrodes (TEs) for applications such as displays, touch screens and/or solar cells [1]. In particular, graphene has outstanding properties to improve the energy-generation devices. In the context of photovoltaic (PV) technology, the implementation of graphene into new TE's architectures for silicon-heterojunction (SHJ) solar cells could offer innovative and low-temperature reliable solutions to generate and extract current in a more efficient way [2]. However, before graphene reaches an industrial production scenario, it is necessary to solve the bottleneck on how a quality control, that permits analysing large areas without damaging it, will be carried out. With this scope, this work presents two mapping procedures to characterising in an efficient macro-scale and non-destructive way, graphene-based structures; more specifically, TEs for SHJ solar cells. Those contactless mapping methods would permit the evaluation of the most important key performance indicators of graphene-based structures and their suitability for a specific application. They would also be very useful to extract information about both the uniformity and the quality of graphene-transfer process. Onyx system from Das Nano company, operating in reflection-mode at Terahertz (THz) wave range, and an optical-transmission-mapping system developed by the authors, have been used successfully to determine the electrical and optical TEs performance, respectively, without damaging the graphene [3]. As example, Figure 1 pictures THz-time domain spectroscopy (TDS) conductance and resistance maps, acquired with Onyx, of an optimised TE based on three graphene monolayers transferred on the conventional transparent conductor oxide material, indium tin oxide (ITO), developed for SHJ solar cell technology.

We demonstrate that the use of such approaches allows opening new horizons to achieve the definitive take-off of graphene-based technologies, and specifically of their engagement in the SHJ contact-technology enhancement.

References

[1] J.H Ahn, et al., Nature Nanotechnol., 9 (2014) 737-738.
[2] M.A. Green et al., Prog. Photovolt.: Res. Appl., 24 (2016) 905-913.
[3] S. Fernández et al., Micromachines, 10 (2019) 402 (11 pages).

Figures

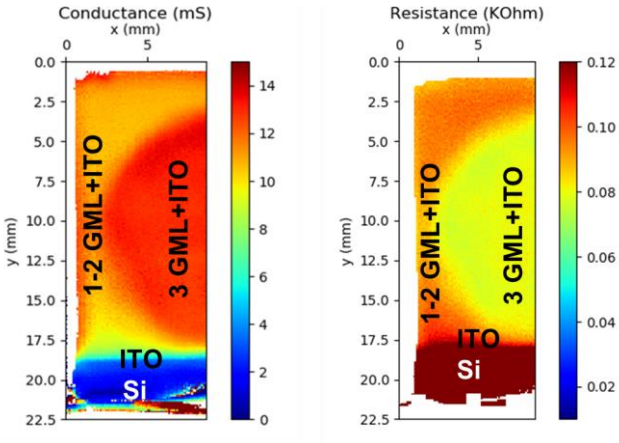

Figure 1: THz-TDS conductance and resistance maps of graphene-based TE acquired with Onyx

Acknowledgements: Supported by MINECO project DIGRAFEN (ENE2017-88065-C1-2R) and (ENE2017-88065-C2-2R)