



An experimentally-validated multi-scale materials, process and device modelling & design platform enabling non-expert access to open innovation in the Organic and Large Area Electronics Industry (MUSICODE)

Grand Agreement: 953187

Project Start Date: 01/01/2021

Project Duration: 48 months

Deliverable 6.1

Lab and large scale OLAE devices with doped organic semiconductors by printing

Date: 17-03-2023



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under the Call

DT-NMBP-11-2020 "Open Innovation Platform for Materials Modelling"

Project co-funded by the European Commission within Horizon 2020 Research and Innovation Programme		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Service)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (excluding the Commission Services)	x

Deliverable author(s): V. Kyriazopoulos, Organic Electronic Technologies P.C. (OET)

Contributors (only the lead contacts during the preparation of this document are identified herein)

Name	Organization
E. Mekeridis	OET
D. Kutsarov	SURREY
V. Appuhamilage	SURREY
A. Paliagkas	AUTH
C. Kapnopoulos	AUTH
A. Laskarakis	AUTH

Copyright

@ Copyright 2021-2024 The MUSICODE Consortium

Consisting of Coordinator:	University of Ioannina (Uoi)	Greece
Partners:	Karlsruhe Institute of Technology (KIT)	Germany
	University of Surrey (SURREY)	UK
	Aristotle University of Thessaloniki (AUTH)	Greece
	Czech Technical University in Prague (CVUT)	Czechia
	Fluxim AG (FLUXIM)	Switzerland
	TinniT Technologies GmbH (TINNIT)	Germany
	Granta design LTD (GRANTA)	UK
	Esteco SPA (ESTECO)	Italy
	Organic Electronic Technologies (OET)	Greece
	Apeva SE (APEVA)	Germany
	AIXTRON SE (AIXTRON)	Germany

This document may not be copied, reproduced, or modified in whole or in part for any purpose without written permission from the MUSICODE Consortium. In addition to such written permission to copy, reproduce, or modify this document in whole or part, an acknowledgment of the authors of the document and all applicable portions of the copyright notice must be clearly referenced.

All Rights reserved.



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under the Call DT-NMBP-11-2020 "Open Innovation Platform for Materials Modelling"

"The European Commission support for the production of this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein."

Glossary

OLAE	Organic Large Area Electronics
OIMMP	Open Innovation Materials Modelling Platform
OPV	Organic Photovoltaic
OE	Organic Electronics
HOD	Hole Only Device
EOD	Electron Only Device
SCCD	Single Charge Carrier Device
HTL	Hole Transport Layer
D	Donor
PAL	Photoactive
A	Acceptor
SE	Spectroscopic Ellipsometry
AMF	Atomic Force Microscopy
RS	Raman Spectroscopy
RMS	Root Mean Square
PL	Photoluminescence Spectroscopy
IPL	Imaging Photoluminescence
RT	Room Temperature

Contents

Glossary	3
Publishable summary	5
1. Introduction.....	6
2. Methodology	6
3. Fabrication & characterization of OLAE devices.....	6
4. Analysis and Results	10
4.1 Doped Hole Only Devices	10
4.2 Doped OPV Devices	20
5. Achievements	27
6. Next steps	27
7. Conclusions.....	28

Publishable summary

This document reports the work carried out in Task 6.1 “Effects of dopants in OLAE nanomaterials properties and device performance (M13-40)” under the WP6 “User cases (M13-M48)” and is related to the 1st User Case. WP6 targets to the implementation of the Open Innovation Materials Modelling Platform (OIMMP) to optimize the fabrication of OLAE nanomaterials and devices by state-of-the-art manufacturing processes. The advantage of utilizing modelling will be demonstrated by the acceleration it contributes to the innovation cycle, which can be measured in terms of reductions achieved in material waste for the development of new nanomaterials and products and the performance enhancements achieved. Task 6.1.1 focuses on the experimental tests and characterization of the fabricated devices, incorporating new record-breaking materials doped with novel doping materials in order to demonstrate further efficiency improvement. These results will be used for the validation of the developed workflows and ontologies.

This report shows the experimental work undertaken during M13 to M26. Doped single carrier devices and small Organic Photovoltaic Devices (OPVs) with photoactive areas below 1 cm² were fabricated by different partners, using the spin-coating technique in conjunction with vacuum deposition, whereas others were fully solution processed. The single carrier devices were used to measure the charge carrier mobilities of doped donor materials (Hole Only Devices, HODs). Also, small OPV devices were fabricated using doped binary blends, in order to assess the effect of the dopants on the OPV devices performance. The fabrication process optimization was carried out, to overcome the difficulties that arose during the first fabrication attempts, while all layers were extensively characterized through several techniques, leading to valuable data on the materials’ optical and structural properties, as well as their correlation with the fabrication process parameters.