D6.3
WP6

COLAE
Commercialising Organic and Large Area Electronics

COLAE: Commercialization Clusters of OLAE

Summary of key future research and topic and key recommendations and report on 3rd and 4th workshops

Project name: Commercialization Clusters of OLAE

Acronym: COLAE

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Website: www.colae.eu

Responsible partner

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Executive Summary

Work package 6 (WP6) – New Wave Research - of COLAE is collecting and analysing information from workshops with stakeholders in the OLAE field in order to generate key recommendations for each of the themes and finally disseminating the results. This deliverable 6.3 reports work done in task 6.4 “Workshop on OLAE processing and manufacturing” and task 6.5 “Workshop on OLAE materials”. The OLAE processing and manufacturing workshop was arranged by CEA in connection with LOPE-C 2013 conference. The OLAE materials workshop was arranged by AUTH together with N&N & ISFOE 2013 event.

As result of OLAE processing and manufacturing workshop several different bottlenecks were identified in materials, components, equipments and processes. In addition challenges were visible also in other topics like collaborative actions, markets, standardization etc. Because the OLAE industry is not mature yet it is too early to set up flexible toolkits for producing any kind of OLAE products. OLAE is still in a technology-push phase and this do not guarantee product performance, reliability and cost requirements regardless of the case of application but would rather deliver variable and hardly predictable performance, reliability and cost. Creating early market opportunities is a critical issue for the OLAE industry. Along these opportunities, creating and unifying strong EU industrial clusters with focused OLAE products as a target benefiting from the support of relevant public-private partnership & infrastructure will be the driving force to success.

OLAE materials workshop was more conference type event than interactive workshop where participants came mostly from academia. The presentations included scientific knowledge of synthesis of novel polymer and small molecule organic semiconductors and optoelectronic materials and well as organic and inorganic hybrid materials. In addition carbon based novel materials including grapheme, fullerenes and nanotubes were presented. Presentation as also included high lights of European gas barrier and encapsulation material research carried out in EC funded projects. General outcome of the workshop was that the OLAE material research is very high level and generates plenty of new innovations and scientific publications.

COLAE project was also actively participating to collaboration and discussion with European Commission, Organic Electronics Association (OEA) and Photonics21 working group 4 about OLAE future. Based on this collaboration a joint vision paper of European strategy for Organic and Large Area Electronics was published in June 2013. The main goal of this vision paper was to serve as an input for the Horizont2020 priority setting process.

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1 Workshops

1.1 3rd workshop on OLAE processing and manufacturing

1.1.1 Introduction

The 3rd COLAE workshop was part of COLAE task 6.4 committed to organize a workshop on OLAE Processing and Manufacturing at the European level with the support of OE-A in connection with LOPE-C 2013 Conference. This event followed a similar one focusing on French SMEs, organized by Plastipolis in Paris on the 26th of March. The responsible partner for this workshop was CEA with supporting partners VTT and FhG.

1.1.2 Organization and attendees

The workshop was organized at 11th of May and co-located with the LOPE-C 2013 Conference in ICM – Munich. The principle of such an event was previously validated with the OE-A directory. An internet page was dedicated to the workshop which was linked to the LOPE-C page.

Prior invitation, a relevant mailing list was established with the help of COLAE partners and networks consolidating contacts from,

- previous COLAE workshops
- OE-A members
- AFELIM OLAE association
- Plastipolis cluster
- Spotted companies from France, Germany and Finland which were suggested by CEA, FhG and VTT partners, respectively

In total, thirty people managed to attend the workshop and around 10 people were interviewed the day after in the LOPE-C booth area. In global, 2/3 of the attendance came from the industry shown in the Figure 1. The participant list is presented in appendix 1.

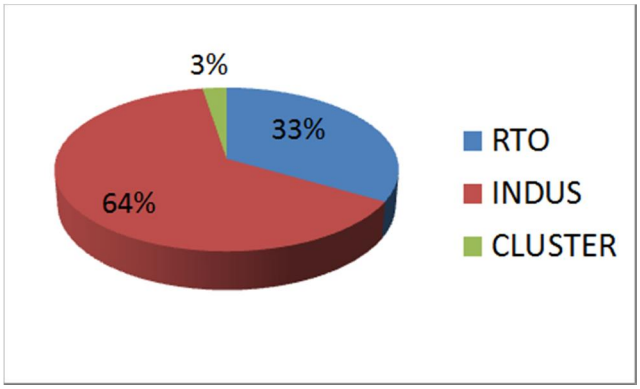


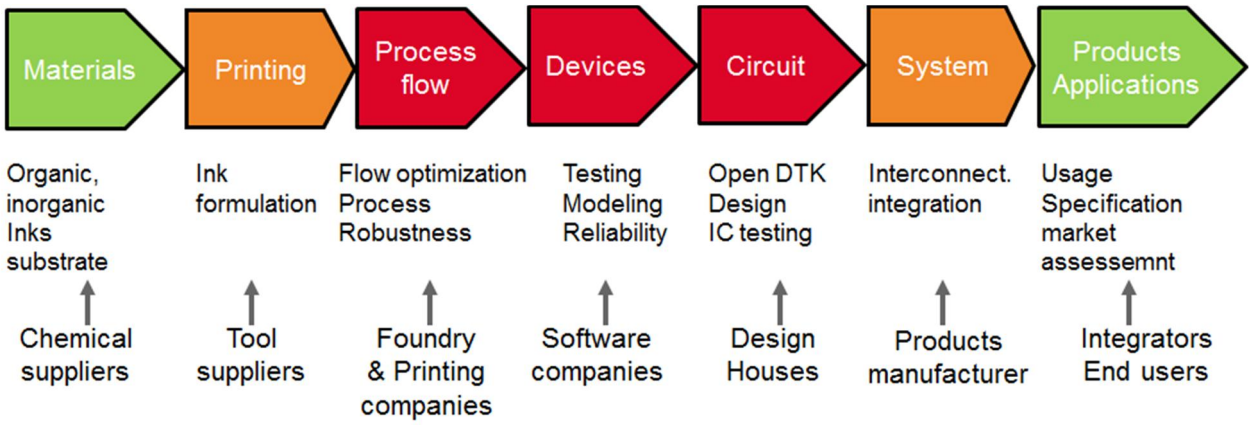
Figure 1.Number of people contributing to the COLAE workshop discussions per organization type.

The workshop agenda was structured in three main parts in order 1) to introduce the attendance to LOPE-C and COLAE, 2) to inform the attendance on general figures from EU activities in OEA and 3) to initiate and drive parallel discussions on R2R / S2S processing & manufacturing as well as process control.

1.1.3 OLAE overview

The workshop was introduced by giving sequentially some general information on OLAEs, a short description of the OE-A association, the LOPE-C conference, the COLAE project & consortium and the COLAE New Wave Research work package from which the workshop originated from. The general information covered,

- A list of representative opportunities for multi-functional organic materials, new paradigm for processing large area & flexible substrates, hybrid materials integration, smart packaging and new industrial players (e.g. printers, plastic molding, paper, textile),
- The © OE-A 2011 roadmap for Organic and Printed Electronics Applications,
- The description of a typical OLAE process chain (picture below), a few representative processes & tooling with examples of process integration schemes.



Then, the main principles and outcomes of the workshop were explained to connect people with expected results of the workshop in terms of:

- Bringing forward the global picture of OLAE manufacturing research and innovation in Europe and highlight the impact of manufacturing in this area,
- Enable the OLAE manufacturing communities in Europe to identify joint collaboration and application areas, and gain new contacts and new ideas for strategic industrial partnerships,
- Make key recommendations on future research needs in the OLAE manufacturing domain and review the existing manufacturing roadmaps for the development of OLAE in Europe, in relation to the launching of the future Horizon 2020 program scenario.

Then, an overview was given on the EU activity in OLAE field with some focus on process and manufacturing at the final stage of the EU Seventh Framework Programme (FP7). Main figures were presented on the EU projects portfolio per type of EU program, EU projects coordination per country and EU platform facilities per country as presented in the Figure 2.

Table 1. FP7 funded projects on OLAE or related applications (not including 7th call)

FP7 CALL - TOPICS	EU PROJECTS
Lighting & Displays	Fast2Light, OLED100, AEVIOM, CombOLED, CELLO, AMAzOLED, HYPOLED, FLAME, IMOLA, SCOOP
Manufacturing, Integration and Devices	PLACE-IT, COSMIC, POLARIC, FLEX-O-FAB, TREASORES, FLEXIBILITY, OLAtronics, INTERFLEX, CHIP2FOIL, e-LIFT, LOTUS, MOMA, PRIAM, 3PLAST, ORICLA, PriMeBits, TDK4PE, LAMP, CLEAN4YIELD
Materials & Sensors	BIOEGOFET, PHOTO-FET, ONE-P, INGENIOUS, SUNFLOWER, X10D, FACESS, PRIMA, HIFLEX, ROTROT
Projects structuring the OLAE area	PolyNet, FLEXNET, OPERA, PolyMap, PRODI

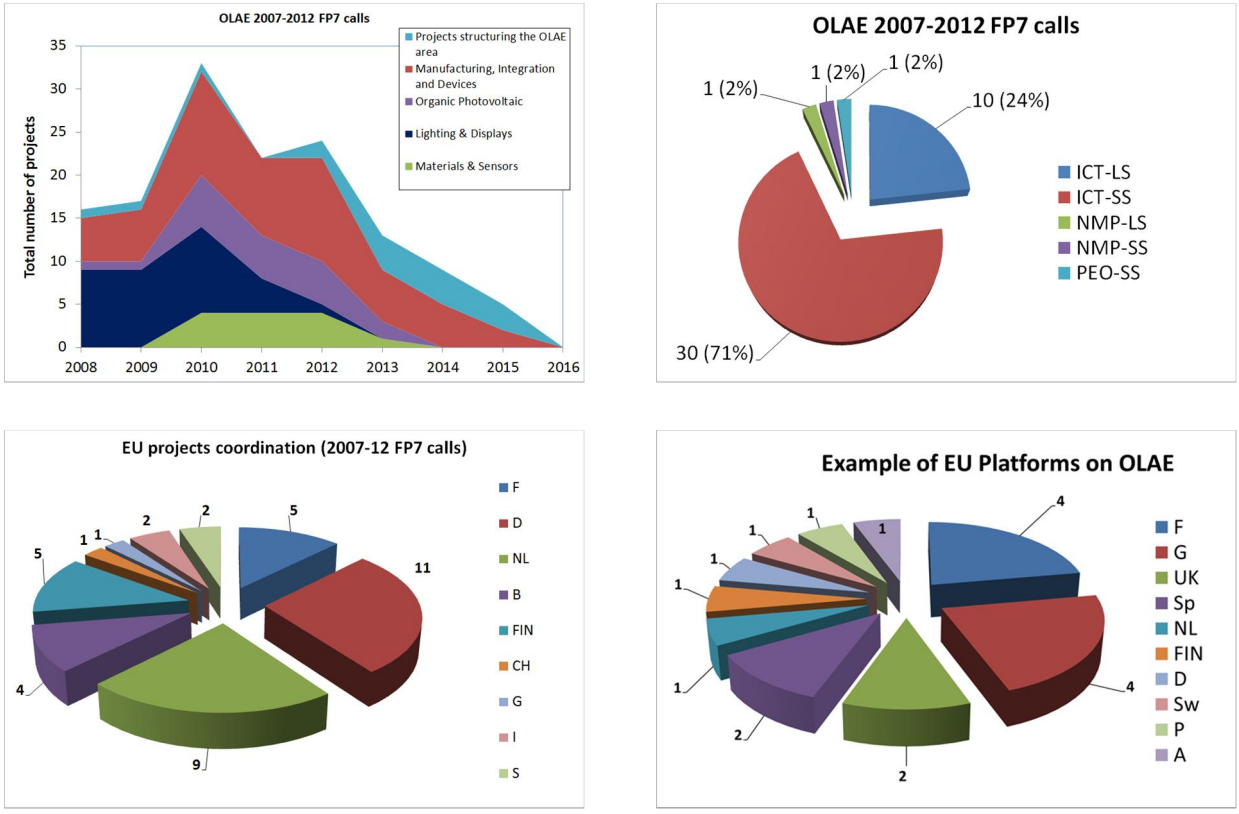


Figure 2. Main figures of the EU OLAE projects portfolio per type of EU program, EU projects coordination per country and EU platform facilities per country

1.1.4 EU projects in the field of OLAE

In a second part of the workshop, representatives of five EU consortia leading projects in the fields of OLAE were invited to give an overview on their latest achievements as well as bottlenecks they were facing in their work towards their ultimate objectives. Particularly, the speakers were asked to emphasize any aspects and issues directly linked to processing and manufacturing as examples to initiate the round tables discussion in the last part of the workshop.

CLEAN4YIELD
http://www.clean4yield.eu/
Representative: TNO
Typical Processing & Manufacturing issues & associated impacts:

- Surface preparation (cleaning, static electricity control, stripping quality,...) and processing environment (particle control, cleanroom level,...) are key aspects for R2R manufacturing which determine contamination levels and hence eventual production yield & cost.
- Process control (within-substrate thickness uniformity, substrate-to-substrate thickness reproducibility), R2R process procedures repair strategies were also spotted as critical for insuring adequate production yields.

POLARIC
http://www.vtt.fi/sites/polaric/
Representative: VTT
Typical Processing & Manufacturing issues:

- In the case of highly densified functionalities (e.g. OTFT), improving the pattern resolution (in printing) and capability for process self-alignment (where the critical patterns of the thin film layers are automatically aligned in respect to each other in the roll-to-roll fabrication process) are key aspects in simplifying the process flow and to improve the product performance.
- While some process can achieve high resolution (e.g. roll-to-roll based nanoimprinting lithography – R2R-NIL) producing very fine patterns (e.g. sub-micron) and larger patterns (tens of microns to hundreds of microns in width) at the same time over a large-area web remains a problem. For example, it is very difficult to pattern electrical wirings between the devices in an integrated circuit using NIL.

ROTROT
http://cordis.europa.eu/fp7/ict/photonics/docs/factsheets/rotrot-factsheet_en.pdf
Representative: CEA
Typical Processing & Manufacturing issues:

- In the case of transparent substrate/superstrate applications (E.g. OPV, lightings), processing materials & coatings condition the lifetime of the product functionalities and therefore have direct impact on the product overall productivity along its operational life and associated cost of ownership.
- The choice of materials (transparent and conductive substrate, active materials (high band gap polymer and low band gap polymer with complementary absorption spectra, acceptor materials), recombination layer, transport layer, barrier material) is crucial. It must be compatible with the R2R process and will subsequently condition the performance of the device and its cost.

X10D
http://www.x10d-project.eu/public
Representative: TNO
Typical Processing & Manufacturing issues:

- The introduction of new materials and simplification of the process flow are requested to gain in product performance & efficiency. Materials with higher performances (lab scale new molecules and polymers) must be produced from high throughput equipment. Often, it also requests the adaptation of materials and/or inks to specific process windows and environmental constraints (e.g. nontoxic solvents). In addition, process flows must be simplified to reduce the impact on cost, embodied energy and carbon footprint.
- Rapid testing capability using advanced characterization techniques is necessary to evaluate the performance of new materials and blend combinations.
- Usual coating techniques have proven process capability for OLAE although up-scaling of process (scribing, coating of layers, encapsulation) with high throughput equipment (R2R - slot die, flexography, ...- evaporation, spray) still remain strong challenges to reach manufacturing feasibility.

COSMIC
http://www.project-cosmic.eu/index.html
Representative: FhG
Typical Processing & Manufacturing issues:

- R2R, S2S and W2W process flow must be envisioned and developed from design to manufacturing (by developing different demonstrators on every technology level the complete cycle of specification, design & layout, fabrication, measurement & evaluation is walked three times) to guarantee process flow suitability and capability towards production worthiness.

In summary, even though CLEAN4YIELD, POLARIC, ROTROT, X10D and COSMIC do not represent the whole EU projects portfolio on OLAE, these five projects still give a representative overview of typical issues faced by developers wishing to implement materials and process solutions into manufacturable and cost competitive products. All these materials, processing and characterization issues identified at R&D level are bound to impact OLAE products performance, maturity, reliability and cost if not addressed and solved at manufacturing scale.

1.1.5 Round tables on OLAE processing, manufacturing and process control

In a third and final part of the workshop, two round tables were organized to discuss R2R and S2S issues related to processing and manufacturing. The attendance was split in two groups of even balance with an objective to name processing and manufacturing issues of general interest they may have experience on in past, present or future activities. The outcome of the two round tables discussion is summarized in the table below.

PROCESS	BOTTLENECKS
Nano-imprinting lithography	Multi-scale patterning on large areas.
Lithography	Potential for patterning small and large area but limitation to exposing the entire resist. Also, multistep lithography process flow become
Gravure printing	(In the case of large area sensors) gravure printing repeatability remains two low.
Ink jet process	♦ Needs for collaborative approach between equipment manufacturers, heads manufacturers and materials suppliers to develop optimized ink jet solutions. If some links are already established between certain companies it would still deserve to be tackled in a more global manner and at a larger consortia scale. ♦ Bottlenecks are not that much technical but the general issue is more on structuring a complementary partnership with well identified markets and end-users to leverage sufficient budget investment with shared risks to lead a proper development program. Finding or creating such opportunities is the bottleneck.
Slot die	♦ Capability for coating simultaneously two sides of a substrate (e.g. flexible batteries). ♦ Patterning capability. ♦ Printing technology is1% material + 99% of solvent which is not compatible with green mass production.
Lamination / delamination	♦ Processing of fragile substrates (e.g. glass). ♦ Suitable adhesive materials. ♦ Distortion of polymer substrates with a low glass transition temperature (normally the cheap polymer foils)
Curing	♦ Oven throughputs are low, equipment footprint is high, process reliability and uniformity

	is insufficient. ♦ Photonic curing should be encouraged mimicking solutions from the microelectronic industries
Screen printing	Printing resolution and quality is dependent on ink quality, head design and surface preparation of a substrate. There are no catalogue solutions optimizing these 3 parameters for a given device and application which transfers the R&D load & risk downstream the chain at the device maker step.
Surface preparation / treatment	♦ No recognized process or methods for preparing a surface which determines interfaces quality with an impact on product performance and lifetime. Some solutions exist (e.g. plasma processing) which are not readily implementable in a process flow though and whose efficiency depends much on materials constituting the substrate and coatings. ♦ Surface contamination with residual polymer material in the case of laser treatment
Atomic Layer Deposition	♦ Although this process delivers high quality coatings on complex substrate shapes and surface topography, ALD remains slow and doesn't offer pattern capability. Would this latter function be doubled in the future? ♦ Needs for post-processing.
Components for processing equipment	For some key components (e.g. squeegees for ink) the best choice of materials & design is strongly dependent on the substrate and process chemistries. While the choice of materials & design is large enough, finding the best candidates requires time/money consuming testing and benchmarking each time a new product is considered. There is no deterministic method.
Gravure printing	(In the case of printed transistors) improving resolution (minimum feature size) of the printed patterns in order to decrease the device footprint in R2R production
Flexographic printing	(In the case of printed transistors) improving resolution (minimum feature size) of the printed patterns in order to decrease the device footprint in R2R production
(Polymer) Materials	(In the case of piezoelectric polymers) there are no technical issues on formulation or scaling up materials. The bottleneck is economic: no mass markets and no clear vision for such markets (!)
Semiconductor inks	Improved charge-carrier mobility combined with excellent printability on R2R is required. Polymer based semiconductors are not there yet, neither are carbon nanotube based inks. Furthermore, for R2R production these should be available in large quantities at low costs.
Insulator materials and processes	(In the case of printed transistors) when the critical feature size of the device (channel length) is downscaled, the thickness of the gate insulator layer should also be downscaled.
Photolithography	Slow process due to Step & Go approach.
INTEGRATION	
Process integration	♦ Process speed mismatch (e.g. slot die relatively faster than drying or curing steps) ♦ In-line integration of vacuum processes (e.g. metal sputtering for back electrodes) with R2R processes
Processing equipment integration	Machines manufacturers must optimized their integration of processing units to insure that a process flow will perform efficiently. Design, chemical, mechanical, electrical,… integration towards productive and energy/materials efficient equipment is challenging. In addition, flexibility is requested when the processing chemicals window is large.
PROCESS CONTROL	
Defects detection	Large area mapping and multi-materials compatibility. On-line detection.
R2R registration concepts	High-resolution on-line registration concepts enabling high-throughput large-area production on R2R. For the device fabrication concepts on R2R, novel approaches enabling self-alignment of the critical patterns.
R2R on-line quality control	Reliable and low-cost on-line measurements e.g. for thin film thickness, also for multi-layer devices.
OTHER	
All organic	Product lifetime is general and critical bottleneck. Durable solutions must be found in

technologies	accordance with each application requirements.
Standardization	Standards for equipment, design to product, process, materials, product functionality.
Market	More activities and novel concepts/approaches for collaborative identification & invention of new product ideas.

1.1.6 Key findings

From a technical standpoint, processing and manufacturing of OLAE devices are facing several challenges with variable criticality at different steps of the process flow. Individually, each single challenge may be differently addressed and specific solutions should be found from existing approaches or arising from novel concepts. However, which makes the situation particularly difficult for OLAE commercialization is the sum of a relatively large set of scattered issues with sometimes interdependencies. For instance, ink jet process improvements require not only better ink materials and better performing inkjet heads but also the co-development of these two in conjunction with the substrate, which substrate depends on each given device and application. However, gathering a material supplier with a component/equipment developer together with the device/product manufacturer is unlikely unless a very strong market opportunity arises. Moreover, it appears that a general approach starting from materials, components and/or equipment knowledge to propose a flexible toolkit for producing any kind of OLAE products is simply not realistic (or too early) as the OLAE industry is not mature yet. This technology-push approach would not guarantee product performance, reliability and cost requirements regardless of the case of application but would rather deliver variable and hardly predictable performance, reliability and cost. Intrinsically, organic based products are also bound to experience fast ageing which jeopardizes any commercialization unless appropriate maturity and ageing resistance is provided and demonstrated. So practically, market-pull seems to be the only viable approach which will set cases of commercially worthy applications from which partnership will naturally emerge and consolidate to develop and deliver robust solutions for processing and manufacturing. Creating early market opportunities is a critical issue for the OLAE industry. Along these opportunities, creating and unifying strong EU industrial clusters with focused OLAE products as a target benefiting from the support of relevant public-private partnership & infrastructure will be the driving force to success.

MATERIALS	COMPONENTS	EQUIPMENT	PROCESS	OTHERS
Resolution, specific properties, green & efficient materials,	Performance by design	Surface preparation, Throughput, process line integration, process control for multi-materials products, reliable & low cost online control	Resolution, Multi-scale patterning, Repeatability, recto-verso processing, green approaches,	Collaborative approaches, no/little markets , standards

1.2 4th workshop on OLAE materials

1.2.1 Introduction

The workshop on OLAE materials took place at Porto Palace Hotel in Thessaloniki between 8th-10th July 2013. It was organized as a part of 6th International Symposium on Flexible Organic Electronics (ISFOE13). The Workshop on Organic and Large Area Electronic (OLAE) Materials revealed, discussed and contributed to solving the fundamental issues that cover the synthesis, thin film fabrication of new organic semiconductor (conjugated polymers, evaporated small molecules or solution processed small molecules) and electrode materials, efficient charge transfer mechanisms, optimization & control of morphology. The topics of the workshop included;

- Polymer Organic Semiconductors
- Small Molecule Organic Semiconductors
- Novel organic/inorganic and hybrid materials
- Graphene, Fullerenes, and Carbon Nanotubes in Organic Electronics
- Transparent Electrodes (organic, printable, inorganic, oxides), non-transparent Electrodes & dielectrics
- Barrier Materials and Encapsulation Methods

1.2.2 Program and participants of the workshop

A list of participant and the workshop program is shown in ANNEX 2. There were totally 34 lectures (3 keynote, 5 invited, 2 projects and 24 regular presentations) during the workshop and main contribution in the presentations came from universities or research institutes. FP7 project TDK4PE was present in this workshop.

1.2.3 Key findings

OLAE materials workshop was conference type event than interactive workshop where participants came mostly from academia. The presentations included scientific knowledge of synthesis of novel polymer and small molecule organic semiconductors and optoelectronic materials and well as organic and inorganic hybrid materials. In addition carbon based novel materials including grapheme, fullerenes and nanotubes were presented. Presentation as also included high lights of European gas barrier and encapsulation material research carried out in EC funded projects. General outcome of the workshop was that the OLAE material research is very high level and generates plenty of new innovations and scientific publications. Here material research highlights from the keynote and invited presentations are listed:

- J. Anthony (Keynote): His talk was focused on small soluble organic semiconducting molecules and their intermolecular interactions. He also explained the side functionalization of small molecules to induce pi-stacking and from layered structures like the example of the modified edge molecules of TIPS-P we can change the interaction and the orientation (packing) and finally the mobility. At the end he presented bulk heterojunction acene solar cells with >1%PCE
- S. Grigorian (Invited): He explained how to relate the device performance with structure properties as they can revealed by High Power X-Rays (Synchrotron). What was found is that for dip-coated P3HT films there is structural anisotropy parallel and perpendicular to the dipping direction.

- S. Lannota (Invited): Prof. Lannote presented Supersonic Molecular Beam Epitaxy (SuMBE) method for growth of molecular films e.g. Pentacene and Oligothiophenes. The principle SuMBE is using hyperthermal Supersonic beam source for organics: they use a carrier gas to carry the molecules. With this method they fabricated OTFTs that had mobilities higher than the reported one and there are Perspectives to sensing applications
- T. Anthopoulos (Keynote): He presented solution processed semiconductors for devices like transistors and other nanostructured organic electronics. He also compared the polymer and small molecule semiconductors (polymers good processability but low mobility compared to small molecules). He proposed the use of blends of small soluble molecules and polymers (diF-TESADT:PTAA 1:1 wt%). What was found is that the film morphology does not affect the mobility and also that there are missing small molecules from the grain boundaries. The high grain boundary conductivity is believed to be the reason for the morphology-independence hole transport observed in these blends
- S. Ludwigs (Invited): She gave a talk about branched architectures and the charge transport measurements were done using OTFT device. As an example she mentioned the PCPDTBT.
- S. Ogier (Invited): He presented the activities of CPI on OTFT backplane processing method (up to 7 samples simultaneously). For the OTFT high permittivity binders and high mobility small molecules blends they achieved over 5 cm2/Vs mobilities (FlexOS TM formulation TIPS-Pentacene & PTAA binder).
- J. Hast (Invited):He presented all R2R processes that are available in VTT for OLEA material and component processing. In addition all R2R printing process for OLED manufacturing was presented.
- P. Blom (Keynote Prof. P. Blom explained the mechanism of charge transfer in Polymer Light Emitting Diode (PLED) and the Electron Trapping in OLEDs. Key role in the charge trapping plays the existence of H2O (moisture) which also contributes to photoluminescence quenching and polaron photogeneration.
- W. Steinmann: She presented a work on Piezoelectric sensor fibers & Fiber based solar cells. For both applications it is essential to find the electrode materials. As it is well known the PEDOTPSS has medium conductivity and difficult processing to fibers. For this reason the Nanocomposites are very promising and they used Ag NW combined with polypropulene. The process involved mixing the Ag NW suspension with PP powder followed by drying to remove volatile molecules. Finally for the fabrication they used melt spinning method
- K. Noller (IVV) and J. Fahlteich (FEP): Both researcher from the two Fraunhofer Institutes gave a picture for producing high barrier films for Organic Electronic devices fabrication. Both institutes are experts in R2R production of barrier films by Physical Vapor Deposition and Atomic Layer Deposition methods and reported WVTR values below 10^{-3} gr/cm^{3}day. Their results are valuable for the R2R production of printed electronics with long lifetime. Dr Fahlteich also showed the novoFlex 600 system combining evaporation, sputtering and PECVD for high barrier film production

2. COLAE input to OLAE field future visions

An important objective in WP6 is also to generate key recommendations for OLAE stakeholder network to influence OLAE field's future activities, especially, in Horizont2020. The COLAE project was actively participating to collaboration and discussions with European Commission, Organic Electronics Association (OEA) and Photonics21 working group 4. Based on this collaboration a joint vision paper of European strategy for Organic and Large Area Electronics was published in June 2013. The main goal of this vision paper was to serve as an input for the Horizont2020 priority setting process.

In the vision paper building blocks of European research hand innovation strategy in the OLAE field was introduced. Three main development axes were identified:

1. Getting more application-driven and providing solutions to end-users
2. Accelerating and improving success along the route to manufacturing (process robustness improvement enabling transfer from lab to fab) with the aim of extending existing or creating new manufacturing sites in Europe
3. Increasing the device performance of components and the level of integration and complexity towards systems

According to the vision paper to ensure industrial leadership in OLAE in Horizont2020 following measures are being considered:

1. Roadmap based research on OLAE technologies
2. OLAE manufacturing platforms aimed at (i) getting more application-driven and providing innovative solutions to end-users; and (ii) accelerating the route from "lab to fab" for crossing the valley of death
3. Demonstration actions
4. Access to technology and actions for innovative SMEs
5. Collaboration among and with innovation clusters in OLAE
6. Inducement prizes
7. Forster the involvement of new industrial actors to adopt OLAE solutions and further networking, outreach, training and education

Finally in the vision paper impact and monitoring issues were discussed. The OLAE field is seen to be able to contribute to addressing several grand societal challenges identified by the Europe 2020 strategy: climate action, resources efficiency and raw materials, smart, green and integrated transport, health, demographic change and wellbeing and food security, sustainable agriculture, marine and maritime research and the bio-economy.

Monitoring is important to understand situation of OLAE in global field and following measures were proposed:

1. The impact on industrial leadership and the market share of each OLAE electronics sector will be measured (by growth potential and by the European market share of each sector).
2. The structuring (with extension towards end-users) and networking of the community will be monitored. Indicators are the participation across the value chain, the involvement of new actors and the degree of consultation within the stakeholder group for OLAE.
3. A measure for the research excellence is the number of peer-reviewed research papers published of advanced or new OLAE devices and their manufacturing technologies.
4. The number of registered patents and licenses as well as the number of start-up and spin-off companies created
5. The size of capital investments and the additional jobs (in existing or new firms) that are created.

Appendix 1.

NAME	FORENAME	ORGANIZATION	MEETING PLACE
ALLEN	Mark	NOKIA	COLAE Workshop
ANDRIESSEN	Ronn	Holst Cente	COLAE Workshop
BACKLUND	Tomas	MERCK CHEMICALS	COLAE Workshop
BACKMAN	Antti	DELEKTRE Ltd	COLAE Workshop
BERNARDS	Jan	FONDYS UNIVERSITY	COLAE Workshop
BOVERHOF	Adrie	VDL FLOW	COLAE Workshop
CALDERON	Enric	CETEMMSA	COLAE Workshop
EULENBURG	Moritz Graph zu	INOVIS COAT	COLAE Workshop
FAHLTEICH	John	FRAUNHOFER	COLAE Workshop
FILLON	Bertrand	CEA	COLAE Workshop
GAVILLET	Jérôme	CEA	COLAE Workshop
GOMES	Joao	CENTI	COLAE Workshop
KAISTO	Ilkka	VTT	COLAE Workshop
LANNEAU	Aurore	PLASTIPOLIS	COLAE Workshop
LEMAITRE	Noëlla	CEA	COLAE Workshop
LIEBEL	Gerhard	PINK THERMOSYSTEME	COLAE Workshop
LOSCOS	Eduard	CETEMMSA	COLAE Workshop
MAANINEN	Arto	VTT	COLAE Workshop
NIELSEN	Maick	TSE TROLLER	COLAE Workshop
PIEKARSKI	Jacek	INST. OF ELECTRON TECHNOLOGY	COLAE Workshop
SANOSTROM	Audreas	LUNALEL	COLAE Workshop
SODERLUND	Mikko	BENEQ	COLAE Workshop
SOLEHMAINEN	Kimmo	VTT	COLAE Workshop
STAFSHEDE	Patric	LUNALEL	COLAE Workshop
STAN	Sorin G	VDL FLOW	COLAE Workshop
VAN DEN HEUVEL	Huib	VDL FLOW	COLAE Workshop
VOLBUSEK	Thomas	COATEMA	COLAE Workshop
Weissflog	Gotthard	OLED NETWORK OLAB	COLAE Workshop

WILLE	Axel	FRAUNHOFER	COLAE Workshop
KUCUKPINAR-NIARCHOS	Esra	FRAUNHOFER	COLAE Workshop
BORELLA	Mathias	CERADROP	LOPE-C Booths
DORAN	Michael	NOTION SYSTEMS	LOPE-C Booths
DUFFIE	Corinne	SOLVAY	LOPE-C Booths
GIESSMANN	Andreas	COATEMA	LOPE-C Booths
LOEWEN	Bernhard	INOMETA	LOPE-C Booths
POSTADA	Michael	IFM	LOPE-C Booths
TORBJORN	Eriksson	THINFILM	LOPE-C Booths
WALSH	Christine	VINCI	LOPE-C Booths
WINTER	Stefan	RKS	LOPE-C Booths

Appendix 2.

Monday 8 July 2013

09:15 – 11:00	Workshop on OLAE Materials I (supported by FP7 COLAE) – ROOM: Crystal Hall Chairs: Prof. G. Hadziioannou, *LCPO, France,* Prof. G. Horowitz, *CNRS, LPICM, Ecole Polytechnique, Route de Saclay, 91128 Palaiseau, France*
09:15 – 09:45 KEYNOTE	Crystal engineering approaches to organic semiconductors J. E. Anthony *Department of Chemistry, University of Kentucky Lexington, KY, 40506-0055, USA*
09:45 – 10:00	Introducing Organic Semiconductors onto Carbon Allotropes A.K. Andreopoulou,[1,2] S. N. Kourkouli,[1] S. Kakogianni,[1] P. Giannopoulos,[1] J. K. Kallitsis[1,2] *[1] Department of Chemistry, University of Patras, Greece, [2] Foundation for Research and Technology Hellas, Institute of Chemical Engineering Sciences (FORTH-ICE-HT),Patras GR 26504, Greece*
10:00 – 10:15	Design of well-defined semi-conducting graft and block copolymers: A tool box for nanostructured materials in organic electronics Cyril Brochon[1,2], Sébastien-Jun Mougnier[1,2], Eric Cloutet[1,2], Georges Hadziioannou[1,2] *[1]LCPO, Université de Bordeaux, 33607 Pessac, France, [2] LCPO, CNRS, 33607 Pessac, France*
10:15 – 10:30	Fabrication and Scale-up of High Performance Low Band-gap Polymer Solar Cells by Spray-Coating in Air T. Wang, N. Scarratt, D. Lidzey The Department of Physics and Astronomy, The University of Sheffield Hicks Building, Hounsfield Road, Sheffield, UK
10:30 – 10:45	High-Mobility, Low-Voltage Organic TFTs based on Air-Stable DNTT Derivatives: Time-Dependent Improvement in Contact Resistance and Dynamic Performance Ulrike Kraft1,2, Ute Zschischang1, Kazuo Takimiya3, Edwin Weber2, Hagen Klauk1 *[1] Max Planck Institute for Solid State Research, Heisenbergstr. 1, 70569 Stuttgart, Germany, [2] Inst. for Organic Chemistry, TU Bergakademie Freiberg, 09596 Freiberg, Germany, [3] Inst. for Advanced Materials Research, Hiroshima University, Higashi-Hiroshima 739-8527, Japan*
10:45 – 11:00	Organic Semiconductors - How to Make Reliable Material Characterization. Experience of NoE FlexNet with Round Robin Testing of Materials J. Pfleger1, I. Tszydel2, T. Marszalek2, J. Ulanski2, M. Zagorska3, P.Tassini4, H. L. Gomes5, S. Kennou6, S. Logothetidis7, C. Gravalidis7 *[1] Institute of Macromolecular Chemistry AS CR, Heyrovsky Sq.2, 162 06 Prague, Czech Republic; [2] Technical University of Lodz, Poland; [3] Warsaw University of Technology, Poland; [4] ENEA, Portici, Italy; [5] University of Algarve, Portugal; [6] University of Patras, Greece; [7] Aristotle University of Thessaloniki, Greece*
11:30 – 13:30	Workshop on OLAE Materials II (supported by FP7 COLAE) – ROOM: Crystal Hall Chairs: Dr. S. Iannotta, *IMEM-CNR, Institute of Materials for Electronics and Magnetism, Italy,* Prof. J. Kallitsis, *Department of Chemistry, University of Patras, Greece*
11:30 – 12:00 INVITED	Direct Correlation of Structure and Electrical Performance of Conjugated Poly(thiophene) Films S. Grigorian *Institute of Physics, University of Siegen, Germany*
12:00 – 12:15	Study of interface composition in polymer:fullerene solar cells P.G. Karagiannidis, A. Laskarakis, D. Georgiou, M. Seitanidou and S. Logothetidis Lab for Thin Films, Nanosystems & Nanometrology (LTFN), Physics Department, Aristotle University of Thessaloniki, Greece

12:15 – 12:30	Thin layer deposition of PEDOT by PRAP-CVD Bianca Rita Pistillo, Kevin Menguelti, Damien Lenoble *Centre de Recherche Public - Gabriel Lippmann (Science and Analysis of Materials Department) 41, rue du Brill, Belvaux, Luxembourg*
12:30 – 12:45	All-Atom Molecular Dynamics Simulation of the Structural, Thermodynamic, and Packing Properties of the Pure Amorphous and Pure Crystalline Phases of Regioregular P3HT Orestis Alexiadis, Vlasis G. Mavrantzas *Department of Chemical Engineering, University of Patras & FORTH/ICE-HT, Greece*
12:45 – 13:00	On The Stability Of The Electrical And Photoelectrical Properties Of Organic Solar Cells Conducting Polymers M.Girtan *Photonics Laboratory, Angers University, 2, Bd. Lavoisier, 49045, Angers, France*
13:00 – 13:15	Hybrid fibers with luminescent or magnetic nanocrystals fabricated by sol-gel process for applications Ping Yang, Aiyu Zhang, Yongqiang Cao, Qian Ma, Jirong Wang, Ruixia Shi, Yuanna Zhu School of Material Science and Engineering, University of Jinan, Jiwei Road 106, Jinan, 250022, P.R. China
13:15 – 13:30	Pyrene-Based Materials for Optoelectronic Devices B. R. Kaafarani *Department of Chemistry, American University of Beirut, Beirut 1107-2020, Lebanon*
18:00– 19:30	Workshop on OLAE Materials III (supported by FP7 COLAE) – ROOM: Crystal Hall Chair: Prof. S. Grigorian, *Institute of Physics, University of Siegen, Germany*
18:00 – 18:30 INVITED	"From Growth Studies to Devices: organic and nano-hybrid structure synthesis by kinetic activated processes" S. Iannotta, L. Aversa, P. D'Angelo, R. Mosca, G. Tarabella, T. Toccoli, M. Tonezzer, R. Verucchi *IMEM-CNR, Institute of Materials for Electronics and Magnetism, Parco Area delle Scienze, 37/A, 43124 Parma, Italy*
18:30 – 18:45	Influence of bimolecular recombination on the photoconductivity of organic semiconductors J. Jung and J. Ulanski *Department of Molecular Physics, Technical University of Lodz, Poland*
18:45 – 19:00	Controlled alpha-sexithiophene nanostructure formation in standard and inverted configuration organic solar cells M. Radziwon, A. Goszczak, A.-L. Fernandes Cauduro,M. Madsen, H.-G. Rubahn *University of Southern Denmark, The Faculty of Technology, NanoSYD Alsion 2, 6400 Sønderborg, Denmark*
19:00 – 19:15	Resistive switching effect in doped with metal micro particles polymers Non-volatile memory based on this effect M. Kotova1, M. Dronov2, I. Belogotrohov3 *[1] Department of Physics, Sub department of Condensed State Physics, Lomonosov MSU) Leninskie Gory GSP-1, Moscow, 119991, Russia, [2] A.M. Prokhorov General Physics Institute, Moscow) Wawilova st., 38, 119991, Russia, [3] Federal State Research and Design Institute of Rare Metal Industry "Giredmet", Moscow) B. Tolmachevsky per. 5/1, 119017, Russia*

Tuesday 9 July 2013

09:30 - 11:00	Workshop on OLAE Materials IV (supported by FP7 COLAE) – ROOM: Timber Hall II Chairs: Prof. C. Draxl, *Physics Department, Humboldt-Universität zu Berlin, Germany,* J. Hast, *VTT, Finland*
09:00 – 09:30 KEYNOTE	Novel organic semiconductors and fabrication paradigms for plastic electronics Thomas D. Anthopoulos *Department of Physics & Centre for Plastic Electronics, Blackett Laboratory, Imperial College London, London, UK*
09:30 -	Anisotropic Charge Transport in Semicrystalline Polymer Thin Films

10:00 INVITED	S. Ludwigs *Institut für Polymerchemie Universität Stuttgart, Germany*
10:00 – 10:30 INVITED	Scalable low temperature TFT backplane processes suitable for flexible display applications and high mobility Organic Semiconductor formulations S. D. Ogier, K. L. McCall, S. R. Rutter, M. Palumbo, Y. Uk Lee, L. Evans, L. Winchester, T. Pease *National Centre for Printable Electronics, Centre for Process Innovation, Thomas Wright Way, NETPark, Sedgefield, U.K.*
10:30 – 10:45	Thin-film morphology optimization of organic n-channel transistors based on core-cyanated perylene diimide derivatives M. Sejfic1, U. Kraft1, N. H. Hansen2, J. Pflaum2, U. Zschieschang1, H. Klauk1, R. T. Weitz3 1 Max Planck Institute for Solid State Research, Heisenbergstraße 1, 70569 Stuttgart, Germany, 2 Julius-Maximilians University, 97074 Würzburg, Germany, 3 BASF SE, 67056 Ludwigshafen, Germany
10:45 – 11:00	Phase Morphology in Poly(thiophene)-Fullerene Thin Film Devices D. G. Bucknall[1], N Deb[1], M. Skoda[2] (ISIS, CLRC), B Sumpter[3], A. Karim[4], X. Gong[4] *1 Department of Materials Science and Engineering, Georgia Institute of Technology, Atlanta, USA, 2 ISIS Neutron and Muon Source, Science and Technology Facilities Council, Rutherford Appleton Laboratory, Harwell Oxford Didcot, OX11 0QX, UK, 3 Computational Chemical Sciences Group, Computer Science and Mathematics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA, 4 College of Polymer Science and Polymer Engineering, University of Akron, USA*
11:30 – 13:30	Workshop on OLAE Materials V (supported by FP7 COLAE) – ROOM: Timber Hall II Chairs: Prof. G. **H**orowitz, *CNRS, LPICM, Ecole Polytechnique, Route de Saclay, 91128 Palaiseau, France* Dr. A. Laskarakis, *LTFN, Aristotle University of Thessaloniki, Greece*
11:30 – 12:00 INVITED	Roll-to-roll printed OLEDs J.Hast, M. Tuomikoski, R. Suhonen, K.-L. Väisänen, M. Välimäki, T. Maaninen, P. Apilo, A. Maaninen *VTT Technical Research Centre of Finland, Printed functional solutions centre, Oulu, Finland*
12:00 – 12:15	Production of Transparent High-Barrier Films for the Encapsulation of Organic Photovoltaics K. Noller, O. Miesbauer, S. Kiese, E. Kucukpinar *Fraunhofer Institute for Process Engineering and Packaging IVV, Freising, Germany*
12:15 – 12:30	Vacuum Deposited Functional Films for Flexible Electronics J. Fahlteich1, M. Fahland1, T. Vogt1, S. G?nther1, N. Schiller1 *1Fraunhofer Institute for Electron Beam and Plasma Technology FEP, Dresden, Germany*
12:30 – 12:45	Manufacturing of AgNW-PP fibers and investigation of their suitability as electrode material in fibers with electronic function W. Steinmann, M. Beckers, I. Noll, G. Seide, T. Gries *1Institut für Textiltechnik (ITA), RWTH Aachen University, Aachen, Germany*
12:45 – 13:00	Hybrid Semiconducting - Fullerene Architectures for Organic Photovoltaics S. Kakogianni[1];S. N. Kourkouli[1]; I. Tantis[2]; A.K. Andreopoulou[1,2]; A. Siokou[2]; J. K. Kallitsis[1,2] *[1] Department of Chemistry, University of Patras, [2] Foundation for Research and Technology Hellas, Institute of Chemical Engineering Sciences (FORTH-ICE-HT), Patras GR26504, Greece*
13:00 – 13:15 PROJECT	MOLESOL: All-carbon platforms for highly efficient molecular wire-coupled dye-sensitized solar cells L. Lutsen1, M. Nesladek1, K. Haenen1, D. Vanderzande1, L. Kavan2, M. Fahlman3, M. Graëtzel4, M. Nazeeruddin4, K. Müllen5, X. Feng5, M. Bari6, R. Twohig6, K. Tulloch7, L. Sorbello7, E. Leonardi7, K.P. Loh8 *1Interuniversitair Micro-Electronica centrum vzw, Diepenbeek, Belgium, 2Ustav fyzikalni chemie J. Heyrovskeho, Praha, Czech Republic, 3Linköpings Universitet, Linkoping, Sweden, 4Ecole Polytechnique Federale de Lausanne, , Switzerland, 5Max-Planck Institute for Polymer Research, Mainz, Germany, 6SolarPrint Ltd, Silverstone House, Ireland, 7Dyesol Italia Srl, Rom, Italy, 8National University of Singapore, Singapore*

Wednesday 10 July 2013

09:00 – 11:00	Workshop on OLAE Materials VI (supported by FP7 COLAE) – ROOM: Timber Hall II Chairs: Dr. Jörg Ackermann, *CINAM, France* Dr. C. Koidis, *OET, Greece*
09:00 – 09:30 KEYNOTE	Injection and Transport in Organic Semiconductors P. de Bruyn[1], G.A.H. Wetzelaer[1], L.J.A. Koster[1], D.M. de Leeuw[1,2] and P.W.M. Blom[1,2] *[1] Molecular Electronics, Zernike Institute for Advanced Materials, University of Groningen, The Netherlands* *[2] Max Planck Institute for Polymer Research, Mainz, Germany*
09:30 – 09:45	Contact properties of high-mobility, air-stable, low-voltage organic n-channel transistors based on a naphthalene teracarboxylic diimide R. Rödel1, F. Letzkus2, T. Zaki2, J. N. Burghartz2, U. Kraft1, U. Zschieschang1, K. Kern1,3, and H. Klauk1 *[1] Max Planck Institute for Solid State Research, Stutt. Germany , [2] Institut für Mikroelektronik/IMS CHIPS, Stuttgart, Germany, [3] Inst. de Physique de la Matière Condensée, EPFL, Switzerland*
09:45 – 10:00	Alternative hybrid nanomaterials for transparent electrodes in plastic electronics M. J. Beliatis, S. Ravi. P. Silva *Nanoelectronics Center, AIT Univ. of Surrey, Guilford, UK*
10:00 – 10:15	Deposition of Multiple Layers via Ultrasonic Spray Coating for Use in High Performance Organic Photovoltaic Devices J. Griffin, N. Scarratt, A. Pearson, T. Wang, A. R. Buckley & D. G. Lidzey *Department of Physics & Astronomy, University of Sheffield,UK*
10:15 – 10:30 PROJECT	TDK4PE Project Jordi Carrabina *Centre d'Accessibilitat i Intel·ligència Ambiental de Catalunya, Spain*
10:30 – 10:45	Tailor- made absorber polymers for OPV- from synthesis to formulation development S. Janietz[1], A. Lange[1], E. Katholing[1], St. Albrecht[2], D. Neher[2] *[1] Fraunhofer Institute Applied Polymer Research, Geiselbergstr. 69, D-14476 Potsdam, Germany, [2] Institute for Physics and Astronomy, University Potsdam, KarlLiebknechtstr. 24 -25, 14476 Potsdam, Germany*

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