PolyNet

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Deliverable D4.2.5 (Period 3): Report on the existing training programs for students and young researchers in the field of Organic and Large Area Electronics

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CONTENTS

1 Introduction

The first version of this report (deliverable D4.2.1) was divide in two part. The first part consisted of the analysis of a questionnaire operated in collaboration with PRODI and the Organic Electronic Association (OEA) on the needs on training and formation in the field of organic and large are electronics (OLAE). The second part was constituted by a listing of the existing formations at the Master level in the European universities. A few examples of training programs in the US universities was given for comparison.

Because of the difficulties encountered in performing the questionnaire (the rate of responses was less than 10%), this questionnaire was not renewed during the second and third period of the PolyNet project.

The first update of the deliverable (D4.2.3) focused on a closer identification of the training programs on OLAE in the European universities. For this, a specific questionnaire was sent to each group that has been identified as involved in research programs in the domain of OLAE. Replies to the questionnaire resulted in a good coverage of the existing training programs in France, the UK and several smaller countries in Europe. However, there was obviously a lack of information in Germany, Italy and smaller countries in South and East Europe.

This last update of the deliverable comprises two parts. The first one is a last update of the training programs in Europe, with a particular attention to aforementioned lacks. The second part is dedicated to specific training actions that have been held under the auspices of the PolyNet network; also included in the list are actions organized by the CSA Prodi, another member of the Quadriga.

2 Update of the identified courses and lectures in Europe

The questionnaire used for this last update was identical to that established for the second year report (deliverable D4.2.3). It was sent by e-mail to each university identified in the previous deliverables (D4.2.1 and D4.2.3) involved in research programs in OLAE. Particular attention was given to those groups located in countries that looked under represented in the previous editions of the list.

2.1 Questionnaire on Training and Education in Large Area Electronics

Dear colleague,

Among other objectives, the European network of excellence PolyNet aims at developing a knowledge platform to promote education and training in the domain of organic and large area electronics.

Within the frame of this platform, we have conducted last year an investigation to identify the currently available courses in Europe at the master degree level. The corresponding document is attached to this message, and will be made accessible to the public on the web site of the network at http://www.vdivde-it.de/polynet/public

The first two versions of the document was mainly based on a research through the internet. We are now within the course of establishing a last update the document. For this, we kindly ask you to correct the information concerning your institution by filling the attached form. Please indicate whether your institution provides any course or lecture at the master or doctorate level, and if yes provide the relevant information to describe this formation.

Thank you for your cooperation.

Kind regards.

Yvan Bonnassieux and Gilles Horowitz

The mail was accompanied by the following attached document:

The goal of this questionnaire is to collect broader information about offers from the institutions of education in Training and Education in Large Area Electronics in Europe as a whole and foster the network of the community.

For each Organics lectures in Master or PhD level please give some data as proposed in the table in the next page.

- *Person in charge: Name and email address*

- *Title of the lecture*
- *Level: master (title of the master) or PhD*
- *Teaching method: Lectures or lab work or Seminar*
- *Duration: in hour*
- *ECTS: number of European Credits of the lecture*
- *Aim/Contents: give a short description (5 to10 lines) of the*
- *Training program*

In this questionnaire, we are interested in all that relates to organic electronics in the broad sense: devices (OTFT, OLED, OPV, sensors,…), circuits, physical and behavioural models, organic semiconductor physic, physical/optical and electrical characterization, molecules and polymers synthesis for organic electronic…

If your institution does not provide a full lecture but only some points in the organic electronic fields in another lecture please put the data on the next table.

For your university, we have found some data on the internet. Please can you verify and modify accordingly.

If you have any question, please contact:

- *yvan.bonnassieux@polytechnique.edu*
- *horowitz@univ-paris-diderot.fr*

Thanks a lot for your help.

Yvan Bonnassieux & Gilles Horowitz

Person in charge	***Title of the lecture***	***Level***	***Teaching methods***	***Duration***	***ECTS***
Aim/Contents					

2.2 Identified courses and lectures

2.2.1 Master courses in Organic Electronics

Two master courses dedicated to organic electronics (in Sweden and France) had been identified in the first delivery D4.2.1. The situation of these two courses at the time of the first update was described as follows:

The course in Linköping University reopened for applications in 2009, but again there were not enough students to actually start the program. However, there are still a number of OLAE lectures that will be detailed in the next sub-section.

As for the course in the South West of France shared by the Universities in Bordeaux, Limoges and Toulouse, it did not actually start because of various administrative reasons.

There was not any further progress during the year passed. To the best of our knowledge, there is currently no operating master course fully devoted to Organic and Large Area Electronics. The next sections described the lectures on OLAE given in more general master courses.

2.2.2 Lectures on OLAE at the Master and PhD level in Europe

2.2.2.1 Lectures & courses in Austria

2.2.2.1.1 Graz University of Technology

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	Organic Semiconductors - Fundamentals and Applications		Lectures	48h	3
Aim/Contents	• Introduction to organic semiconductors • Molecular & crystalline structure, liquid crystals • Theoretical models for the description of the electronic structure • Charge transport in organic semiconductors • Photophysical properties • Nonlinear optical properties. two-photon absorption • Optoelectronic devices (OLEDs, plastic solar cells ...) • Field effect transistors				

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	Organic Electronics	Msc Advanced Materials Science Msc Technical Physics	Lectures Lab work	30h	
Aim/Contents	• Introduction to Pi-Conjugated Materials • Introduction to basic principles of Organic Chemistry • Structure to Property Relations in Organic Semiconductors • Organic Conductors and Coatings • Electrochromic Devices • Sensors • Processing techniques I • Processing techniques II • Basic Principles of Organic and Polymer LEDs • Organic and Polymer LEDs: Displays and Lighting • Organic Solar Cells • Organic FETs				

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	Theoretical and experimental investigation of organic semiconductor materials I and II	Msc Technical Physics PhD Physics	Seminar, presentations & Scientific discussions	64h	

Aim/Contents	• Content Topics dealing with experimental and theoretical investigations of organic semiconductors, which are currently covered in Masters and PhD theses.
	• Previous knowledge expected The cours aims at students in the last year of the Masters program and during their PhD; in particular students whose theses are supervised by the lecturer
	• Objective (expected results of study and acquired competences) In-depth understanding of organic semiconductors. Covered topics include:
	  • quantum-mechanical and spectroscopic investigation of excitation processes
	  • application in electronic and optoelectronic devices
	  • nonlinear optical properties
	  • organic/inorganic hybrid systems
	  • interfaces and nanoparticles
	  • molecular electronics				

2.2.2.1.2 Johannes Kepler University (Linz)

In this university, we have identified two lectures at the master level, and five at the doctoral level.

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Pivrikas	Organic Electronics	MSc Industrial and Polymer Engineering	lecture	3h/week	4.5
Aim/Contents					

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Sariciftci	Lab Course Physical Chemistry III	PhD	Lab work	6h	9
Aim/Contents					

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Pivrikas	Lab Course in Organic Electronics Practical	MSc Industrial and Polymer Engineering	Lab work	5h	7,5
Aim/Contents					

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Arici-Bogner	Chemistry of nanoparticles and their potential applications	PhD	Seminar	2h	3
Aim/Contents					

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Neugebauer	Spectroelectrochemistry	PhD	Lecture	2h	3
Aim/Contents					

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Sariciftci	Science and Technology of Organic Semiconductors	PhD	Seminar	1h	1,5
Aim/Contents					

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Sariciftci	Physics and Chemistry of Organic Semiconductors	PhD	Lecture	2h	3
Aim/Contents					

2.2.2.2 Lectures & courses in Finland

2.2.2.2.1 Åbo Akademi University Finland

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Ronald Österbacka	Organic electronics	Msc Materials Technology	Lecture & seminars		3
Aim/Contents	Principles of operation and device physics of organic electronic devices such as light emitting devices, solar cells, organic transistors, bistable devices, electro-chemical transistors...				

2.2.2.2.2 Oulu University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Tapio Fabritius	Printed Electronics (521217S)	Msc	Lecture		
Aim/Contents	Objective: To give an overview about printed electronics, basic knowledge of used materials and manufacturing methods of large area electronics. Course includes also the basics of passive, active and optoelectronic components. Contents: Materials, conductive inks, conductive and semiconductor polymers. Rheology of inks, viscosity, surface tension, manufacturing methods of large area electronics, gravure printing, flexo printing, screen printing, inkjet, hot embossing, laser processing. Passive components, active components OLED, OSC, OFET. Implementation: Lectures and exercises. A final exam concludes the course.				

2.2.2.3 Lectures & courses in France

2.2.2.3.1 Bordeaux I University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Laurence Vignau	Organic microelectronics	Msc Electronics	Lectures Lab work	45h	

Aim/Contents	• Small molecules – polymers
	  • physicochemical properties
	  • characterization
	• Deposition from the solution
	• Structures of OLEDs; basics of colorimetry and photometry
	• Materials in OLEDs
	  • active materials (small molecules, polymers)
	  • electrodes
	• Electrical and photometric characterization
	• Improving the efficiency
	  • band engineering; multi-layer systems
	  • fluorescence, phosphorescence
	  • doping
	• OLEDs in displays: State-of-the-art, properties, addressing the pixels
	• OLEDs in lighting: State-of-the-art, properties, obtaining white emission				

2.2.2.3.2 Ecole Centrale de Lyon

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Jacques Tardy	Plastic optoelectronics	Msc Integrated electronic devices	Lectures	2	
Aim/Contents					

2.2.2.3.3 Ecole Nationale Supérieure des Techniques Avancées

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	Organic electronics	Msc Technological innovation	Lectures Lab work	6h 10h	1.5
Aim/Contents					

2.2.2.3.4 Ecole Polytechnique

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Yvan Bonnassieux, Bernard Geffroy	Organic electronics	Msc Electrical engineering	Lecture Lab work	4h 8h	1
Aim/Contents	• introduction to organic semiconductors • charge transport in organic semiconductors • optoelectronic devices (OLEDs, plastic solar cells ...) • field effect transistors				

2.2.2.3.5 Ecole Supérieure des Mines de Saint Etienne

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Jean-Luc Autran	Plastic electronics	Msc MINELEC	Lectures	20h	3
Aim/Contents					

2.2.2.3.6 Lille I university

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Kamal Lmimouni	Molecular and organic electronics	Msc Micro and nanotechnologies	Lectures	15h	3
Aim/Contents					

2.2.2.3.7 Limoges University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Thierry Trigaud	Organic electronics	Msc	Lectures	45h	

Aim/Contents	• Dry deposition techniques for organic thin films
	• Operating mode of the MISFET
	• Charge transport in OFETs in the channel and at interfaces; photoconductivity
	• Interface engineering; the various structures of OFETs; electrical characterization
	• Materials for OFETs; transparent electronics; optical characterization; aging
	• Physics and technology of the deposition techniques
	  • ion beam assisted deposition (IBAD)
	  • silk printing
	• Applications
	  • active matrix
	  • RFID
	  • phototransistors				

2.2.2.3.8 Paris Diderot University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Gilles Horowitz	Organic electronics	Msc Nanochemistry, materials, surfaces	Lectures	12h	2

Aim/Contents	• Introduction to semiconductor physics
	• Metal-semiconductor junctions
	• Charge transport in organic semiconductors
	• Organic electronic devices
	  • OLED
	  • Organic photovoltaic cells
	• The field-effect transistors
	  • MOSFET
	  • OTFT				

2.2.2.3.9 Paul Sabatier University (Toulouse)

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Pascale Jolinat	Organic microelectronics	Msc Micro and nanosystems	Lectures	10h	1.5
Aim/Contents					

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Pascale Jolinat	Organic semiconductors	Msc Materials for microelectronics	Lectures	10h	1.5
Aim/Contents					

2.2.2.3.10 University Joseph Fourier (Lyon)

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Isabelle Chartier		Msc Materials	Lectures	4h	
Aim/Contents	Give a global vision of devices, processes and applications of OLAE to future engineers				

2.2.2.3.11 University Pierre & Marie Curie (Paris)

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
André-Jean Attias	Materials for a sustainable world	Msc	Lectures	8h/48h	6
Aim/Contents	• Introduction to organic semiconductors • Design, synthesis • Transport properties • Photovoltaics				

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
André-Jean Attias	Advanced Functional Materials	Msc at the Ecole Polytechnique Universitaire (EPU)	Lectures	12h/30h	
Aim/Contents	• Introduction to organic semiconductors • Design, synthesis • Transport properties • Photovoltaics, OLEDS				

2.2.2.4 Lectures & courses in Germany

2.2.2.4.1 Jacobs University (Bremen)

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Dietmar Knipp	Organic electronics and photovoltaic	Msc Nanomolecular science Msc communications and systems			5 5
Aim/Contents					

2.2.2.4.2 Technical University of Chemnitz

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Arved C. Hübler		Msc Media production			
Aim/Contents					

2.2.2.4.3 University of Berlin

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Karlheinz Bock	Technologies of Polytronic Microsystems		Lectures	24h	

Aim/Contents	• Overview
	• Materials
	  • substrates
	  • inks and pastes
	  • organic conductors and semiconductors
	• Charge Transport Mechanisms
	• Major device operation principles
	• Fabrication technologies
	• Characterization techniques
	• Integration of systems.				

2.2.2.5 Lectures & courses in Greece

2.2.2.5.1 Aristotle University of Thessaloniki

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Stergios Logothedis	Nanosciences & Organic electronics	Masters of Science			
Aim/Contents	The two year program over four semester's covers, different aspects of nanoscience, nanotechnology and organic electronic. It is based at the thin films laboratory (nanometrology and nanosystems) in the department of physics.				

2.2.2.6 Lectures & courses in the Netherlands

2.2.2.6.1 University of Gröningen

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Bert de Boer	CHMFP05E. Electronic Properties of Polymers: Functional Polymers	Msc Chemical Engineering	Lectures		5
Aim/Contents	This course is about polymers with special optical and electrical properties. More specifically, we will deal with semi-conducting polymers, or conjugated polymers. The latter two notions are more or less equivalent and we will see why. These polymers are new, promising materials. There are also some novel basic phenomena involved, some phenomena that had been predicted to exist or treated theoretically but were not found in actual materials until these polymers came along. Semiconducting polymers show these phenomena and make them experimentally accessible. Physicists were very delighted and began to take interest in polymers, finally. So, one prominent aspect of this field is that it is highly interdisciplinary. This field has evolved through the collaboration of solid-state physicists, polymer chemists, theoretical physicists and chemists, polymer engineers, physical engineers and even electrical engineers. This course consists of 7 Chapters namely: 1. Introduction, 2 Electronic Structure, 3. Interaction with Light, 4. Charge Transport, 5. Solid-state Structure, 6. Synthesis and Molecular Design, and 7. Applications and Device Principles.				

2.2.2.7 Lectures & courses in Spain

2.2.2.7.1 Universitat de Barcelona

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	Molecular Electronics	Master in Nanoscience and Nanotechnology			2.5

Aim/Contents	• Introduction to molecular electronics
	  • Optical and photonic applications
	  • Liquid crystals based devices
	  • Molecular devices for non lineal optics
	  • Photovoltaic molecular devices
	  • Light emitting organic diodes (OLEDs)
	  • Optical based molecular memories
	• Electronic and magnetic applications
	  • Molecular and polymeric conductors
	  • Organic field effect transistors (OFETs)
	  • Organic labels
	  • Flexible screens and electronic paper
	  • Smart fabrics
	  • Molecular and magnetic memories
	• Chemical and biological applications
	  • Molecular sensors (molecular phenomena in electronic nose and tongue)				

2.2.2.8 Lectures & courses in Sweden

2.2.2.8.1 Linköping University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Mats Fahlman	TFYA52 - Organic electronics	Msc	Lectures	42h	6
Aim/Contents	Basic models for electronic structure in organic electronic materials: molecular orbitals, hybridization, from bonds to bands Basic models for optical absorption and luminescence in organic electronic materials: luminisence, phosphoresence, excitons, exciton diffusion, exciplex, exciton dissociation Electrical properties of organic electronic materials: charge carriers, charge transport, charge injection Electro-optical properties in organic electronic materials: electroluminescence and electrochromism Magneto-electro-optical properties in organic electronic materials: magnetoresistance, photo-induced magnetism and magnetically-controlled luminescence Interdependency of structural, electronic and optical properties in organic electronic materials Overview of organic electronic components: light emitting devices, photovoltaic cells, transistors and spin-valves.				

2.2.2.9 Lectures & courses in the United Kingdom

2.2.2.9.1 Bangor University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	Organic Electronics	PhD MPhil	Research	3 years 2 years	
Aim/Contents	Research is undertaken into: Synthesising new monomers and polymers for electronic device application; Fabrication of polymer MISFETs, Schottky diodes, LEDs, electrical and optical characterisation of polymers and devices, AFM/EFM/Kelvin probe studies on fabricated devices				

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
		MSc Organic Engineering			
Aim/Contents	Organic Electronic Devices are now emerging into the market place with Organic Light Emitting Diodes (OLEDs) being used in displays that range from camera viewfinders to large TV screens. Organic materials are also being developed for photovoltaic applications both in combination with oxides and as blends. Organic field effect transistors are now well advanced and are being integrated into sophisticated circuits for active matrix addressing of displays and for radio frequency identification (RFID) tags				

2.2.2.9.2 University of Cambridge

No master course identified at Cambridge University. However, the department of physics (Cavendish Laboratory) offers a list of condensed matter projects to PhD students, which are listed below.

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Henning Sirringhaus	Optical spectroscopy of charge transport in organic semiconductors	PhD	Project		
Aim/Contents	Charges in organic semiconductors interact strongly with intra- and intermolecular vibrational modes. In this project we will use optical spectroscopy over a broad frequency range from the far-infrared to the ultraviolet to study this strong electron- phonon coupling and obtain a better molecular-level understanding of the fundamental charge transport processes in organic semiconductors.				

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Henning Sirringhaus	Photoconductivity of high-mobility organic semiconductors	PhD	Project		
Aim/Contents	Much progress has been made in recent years with the development of organic semiconductors that exhibit much higher charge carrier mobilities than previously accessible. In this project we will study the fundamental photoconductive properties of these materials. We aim to investigate the influence of the mobility on the efficiency of charge carrier photogeneration. This project might lead to novel architectures for realizing organic solar cells.				

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Henning Sirringhaus	Intrachain transport in polymer semiconductors	PhD	Project		
Aim/Contents	Conjugated polymers are one-dimensional, carbon-based semiconductors that should in principle have similarly high charge carrier mobilities and exotic transport properties as what can be observed in carbon nanotubes or graphene. However, this will require measurements of transport on the length scale of individual polymer chains of several 10 nanometers. In this project we will study a class of high-mobility, chain-extended conjugated polymers with the aim of characterizing the fast intrachain transport along the covalently bonded polymer backbone as opposed to the slower interchain hopping processes. Applications in field-effect transistors and solar cells will also be addressed. The project is a fully funded project studentship on an EPSRC programme grant and offers opportunities for collaborating closely with synthetic chemists and materials scientists as well as gaining experience in a broad range of experimental characterization techniques.				

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Henning Sirringhaus	Printed electronics	PhD	Project		
Aim/Contents	This project is an industrially funded PhD studentship in the field of printed electronics. It will investigate the device physics of organic field-effect transistors, in particular the relationship between device architecture, materials processing and device performance and stability. It will make use of a broad range of physical characterisation techniques to achieve a deeper fundamental understanding of the physical processes in device structures that are of direct interest in industrial applications. In spite of its close industrial collaboration the project is structured such that it will allow free publication of the results.				

2.2.2.9.3 Imperial College (London)

Strictly speaking, there is no master course at Imperial College, London. However this university has open a "Doctoral Training Centre" at the PhD level, which is described below.

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	The Plastic Electronics Doctoral Training Centre	PhD			
Aim/Contents	The Plastic Electronics DTC aims to train doctoral scientists in this exciting, fast moving and interdisciplinary field. Students will take a 12 month MRes programme, the MRes in Plastic Electronics (subject to GSEPS and Senate approval) during which they will be taught the physics, chemistry, materials science and device engineering of plastic electronic materials and complete an interdisciplinary research project. They will receive hands-on training in diverse areas including microscopy, printing and processing, device fabrication and molecular modelling. Visiting industrial lecturers will teach advanced courses in the state-of-the-art methods and technology, and an option to develop the MRes project as an entrepreneurship exercise is offered. During the Ph.D., students will pursue their chosen research area in depth, under the guidance of two supervisors from different disciplines, and with continuing participation in advanced courses, and professional skills development. Some students will carry out projects in collaboration with industrial or overseas labs while others will visit such labs for specific measurements. Both experimental and theoretical projects will be available. Examples of project titles include: • Organic solar cells on flexible substrates • Contact printed polymer thin film transistors for liquid crystal displays • Modelling Light Efficiency Enhancement in Polymer LEDs • Hybrid Organic/Inorganic Quantum Dot Photosensitive Devices • Electroabsorption Spectroscopy of organic Light Emitting Diodes • Phase behaviour of binary blend films for organic photovoltaics • Complementary-like logic with organic field effect transistors • Design, synthesis and characterisation of high mobility p-type organic semicondcuctors • Molecular dynamics study of the self assembly of discotic liquid crystals • Organic photodetectors for medical X-radiography • Photophysical study of excited states in donor-acceptor blend films The participating departments are Physics, Chemistry and Materials at Imperial and the School of Materials Science and Engineering at Queen Mary, University of London. Over 40 industrial and academic partners have offered their help in the design and support of projects.				

2.2.2.9.4 University College London

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	PME, PHASG474. Plastic and Molecular Electronics	MSc Nanotechnology	Lectures		
Aim/Contents	Organic semiconducting (macro)molecules; Polymer-based light-emitting diodes (LEDs), Polymer-based photovoltaic diodes (PVDs), Polymer-based field-effect transistors, FETs, Molecular switches and motors, Supramolecular structures and dendrimers, Insulated molecular wires, IMWs and threaded molecular wires (TMWs). Discotic systems (e.g. hexabenzocoronenes (HBC), porphyrine and phthalocyanine, rylenes, perylenes, terrylenes, and quaterrylenes). Core-shell and other encapsulated systems. Biological and/or biomimetic structure of potential interest. Dendrimers and dendronised materials as a tool to control supramolecular architectures. Potential applications.				

2.2.2.9.5 De Monfort University (Leicester)

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	Printable Electronics	Msc MicroElectronics and NanoTechnologies (MEANT)	Lectures		
Aim/Contents	Covers materials (both organic and inorganic) used in printable electronics. You will study properties, fabrication methods, and applications of printable electronic devices such as LEDs and TFTs. You will learn and practice a variety of current and emerging printing methods used to fabricate electronic devices.				

2.2.2.9.6 University of Liverpool

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
William Eccleston	Carbon based electronics	Micro and nano technologies	Lectures	18h	3.75
Aim/Contents					

2.2.2.9.7 University of Manchester

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	Organic and inorganic semiconductor nanostructures	MSc in Nanoelectronics	Lectures		
Aim/Contents	Provide an advanced education in modern Organic and Inorganic Semiconductor engineering, emphasising the physical principles and their practical application Provide practical training into the different stages of the fabrication of nanoelectronic component, from synthesis of the raw material to processing and fabrication of the final device, experiencing all the different stages of assessment				

2.2.2.9.8 University of Sheffield

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
David Lidzey	PHY411 Organic semiconductors	Aspect of modern physics	Lectures	15h	5
Aim/Contents	Course objectives • To understand how semiconducting properties can arise in organic molecules. • To understand the physical concepts and mode of operation of organic semiconductor devices. • To provide examples of organic semiconductors and appreciate their relevant applications. ***Lecture 1.*** Why study organic semiconductors? Applications; 'Organic semiconductors' course-overview; further information ***Lecture 2.*** An overview of carbon chemistry. Using carbon-based materials to create the building-block of organic semiconductors ***Lecture 3.*** The fundamental Excitations of organic semiconductors: Polarons and excitons ***Lecture 4.*** Singlet and triplet excitons ***Lecture 5.*** Coupling to vibrational modes. Emission and absorption of light. Energy migration. ***Lecture 6.*** An overview of molecular materials used in organic electroluminescence ***Lecture 7.*** Operating principles of organic LEDs (OLEDs). ***Lecture 8.*** Injection and charge transport in OLEDs ***Lecture 9.*** Photovoltaic devices. Principles and motivations. Energy from sunlight. Fullerene-based material systems. ***Lecture 10.*** Photovoltaics from conjugated polymer blends. Calculating PV efficiency.				

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	PHY6007 Electronic & Photonic Molecular Materials and Devices	MSc Polymers for advanced technologies MSc(Eng) Polymers and polymer composites science and engineering PhD Integrated studies (Advanced materials)			
Aim/Contents	• Fundamental Polymer Chemistry • Biopolymers and Biomaterials • Polymer Characterisation and Analysis • Polymer Laboratory Course *(the above courses are taught by the Department of Chemistry in semester 1)* • The Physics of Polymers • Polymer Materials Science and Engineering • Polymer Fibre Composite Materials *(the above courses are taught in the Department of Engineering Materials across both semesters)* • Students also have the choice of one option from the following in semester 2:- • Design and Manufacture of Composites • Smart Polymers and Polymeric Materials • Macromolecules at Interfaces and Structured Organic Films • Molecular electronics and photonics				

2.2.2.10 Other European universities

The following universities have been identified as involved in research in OLAE. To the best of our knowledge, no training program is under course in these institutions.

Belgium	Katholieke Universiteit Leuven	University of Ghent
	University of Mons Haunaut	
Czech Republic	Czech technical University in Prague	
Denmark	University of Copenhagen	
Finland	Helsinki University of Technology	Tampere University of Technology
	Jyväskylä University	
France	Ecole Nationale des Ponts et Chaussées	Ecole Nationale Supérieure de Chimie de Paris
	Joseph Fourier University	Louis Pasteur University Strasbourg
	University of Paris Sud Orsay	University of Picardie Jules Verne
	University of Versailles	
Germany	Technical University of Braunschweig	Technical University of Darmstadt
	Technical University of Dresden	Technical University of Erlangen-Nuremberg
	Technical University of Munich	Ulm University
	University of Augsburg	University of Bonn
	University of Freiburg	University of Karlsruhe
	University of Kassel	University of Regensburg
	University of Stuttgart	
Greece	Technological Education Institute of Larissa	
Ireland	Trinity College Dublin	
Italy	Milan Polytechnic	University of Bari
	University of Lecce	University of Milan
	University of Rome	
Netherlands	Delft University of Technology	Eindhoven University of Technology
	Fontys University of Applied Sciences	Radboud University
Poland	Kraków University	Jagiellonian University
	Lodz University	
Portugal	New University of Lisbon	Technical University of Lisbon
	University of Algarve	University of Aveiro
	University of Lisbon	
Slovenia	University of Ljubljana	
Sweden	Chalmers University of Technology	Mid Sweden University
Switzerland	Electronic Technical High School ETH Zurich	Ecole Polytechnique Fédérale de Lausanne
United Kingdom	Durham University	Loughborough University
	University of Bath	University of Cambridge
	University of Hull	University of Leeds
	University of Reading	University of Southampton
	University of Surrey	University of Sussex

3 OLAE lectures & courses in the USA

For the sake of comparison, we give hereafter the description of a few master and PhD courses on organic electronics in the USA. Note that the list does not intend to be exhaustive. The universities were selected upon their known high research level in the field of OLAE. Like in Europe, no master course was identified.

3.1 Lectures in OLAE

3.1.1 Stanford University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	MATSCI343 Organic Semiconductors for Electronics and Photonics	MS Materials Science and Engineering	Lectures		
Aim/Contents	This course if for those students interested in the science of organic semiconductors and their use in electronic and photonic devices. Topics Include • Methods for fabricating thin films and devices. • Relationship between chemical structure and molecular packing on properties such as band gap, charge carrier mobility and luminescence efficiency. • Doping. • Field-effect transistors. • Light-emitting diodes. • Lasers. • Biosensors. • Photodetectors and photovoltaic cells.				

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	MS 9031 Organic Polymer Electronics and Devices	MS Materials Science and Engineering	Lectures	39h	
Aim/Contents	This course will introduce students to area of polymer electronics materials, processing, and applications. It ranges from introduction to synthetic chemistry to device fabrication, materials characterization, and device and materials physics. This course consists of: • Fundamentals of Organic Electronic Materials • Materials & Materials Synthesis • Device Physics & Characterization • Devices & Processing • Applications, Roadmaps				

3.1.2 University of Rochester

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	CHE 430 Organic Electronics	Msc Chemical Engineering	Lectures		
Aim/Contents	Basic optical and electronic processes of organic molecules and polymers. Charge transport and luminescent properties of organic solids. Metal/organic contacts and charge injection. Applications in thin-film organic electronic devices including organic light emitting diodes, solar cells, photoconductors, and transistors. Review of selected papers.				

3.1.3 University of Washington

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	MSE 560 Organic Electronic and Photonic Materials/Polymers	Master Materials Science & Engineering	Lectures		
Aim/Contents	Physical and material concepts determining properties of organic electronic and photonic materials. Discusses electronic structure, physico-chemical characterization, and device application. Includes introduction of electronic band structure of polymers, electrically conducting polymers; organic nonlinear optical electroluminescent materials; polymer optical fibers; two-photon absorption materials for 3-D microfabrication				

3.1.4 University of California at Berkeley

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	(EL ENG) 290Y Organic Materials in Electronics - Electrical Engineering	M.S. in Engineering Ph.D. in Engineering - EECS	Lectures		
Aim/Contents	Organic materials are seeing increasing application in electronics applications. This course will provide an overview of the properties of the major classes of organic materials with relevance to electronics. Students will study the technology, physics, and chemistry of their use in the three most rapidly growing major applications--energy conversion/generation devices (fuel cells and photovoltaics), organic light-emitting diodes, and organic transistors. (F,SP) Subramanian				

3.1.5 University of Texas at Dallas

Person in charge	Title of the lecture	Level	Teaching methods	Duration
	MSEN 5375 (PHYS 5375) Electronic Devices Based On Organic Solids	Msc Materials Science & Engineering Master of Science in Applied Physics	Lectures	3 h/semester
Aim/Contents	Solid state device physics based on organic condensed matter structures, including: OLEDs (organic light emitting diodes), organic FETs, organic lasers, plastic photocells, molecular electronic chips			

3.1.6 University of Pennsylvania

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
	MSE 790 Special topics in electronic materials	Msc Material Science and Engineering	Lectures		
Aim/Contents	This is an advanced graduate seminar course in which several advanced electronic materials systems will be studied in depth. First-year graduate students and exceptional seniors will be permitted to enroll if their background in quantum mechanics and solid state physics is at a sufficiently high level. Grading will be based on a term paper and in-class presentations (2 for grad students, 1 for undergrads). Emphasis will be on structure and composition, electronic properties, synthesis and processing. Topics for study will be selected from the following • Inorganic semiconductors at the cutting edge: optoelectronic alloys based on Ga, P and In nanowires • Noncrystalline solids: hopping and dispersive transport, short-range order and how to measure it, control of electronic properties for thin film transistors,solar cell material requirements • Organic electronic and optoelectronic materials conjugated polymers, electroactive oligomers and small molecules OLED (organic light-emitting diode) materials and devices molecular electronics • Carbon nanotubes, band structure, zone folding, quantum confinement, ballistic and diffusive transport, nanotube electronics • Giant magnetoresistive materials • Spintronic materials				

3.2 Comparison between the USA and the European Union

In spite of the restricted coverage of the courses and lectures in the US, we can highlight the following elements:

- There is a great similarity among the topics covered; the lectures basically address the same fields of competence that include, among others, the chemistry of polymers, solid state and device physics and techniques of thin film deposition.
- Another similarity stems from the fact that the presence of a highly recognized research group does not necessarily implies the presence of a training activity. For instance, no lectures on OLAE were identified in the university of Princeton (Antoine Kahn's group), the university of Northwestern (Tobin Marks' group) and the university of Minesota (C. Daniel Frisbie's group).
- It is worth mentioning that, at variance with what we found in the European Union, the US universities do not seem to offer any master course entirely devoted to OLAE. All the detected courses and lectures are included in more general Masters (usually physics or chemistry of polymers).

4 OLAE lectures & courses in Asia

Again, the following list is not exhaustive. It is mainly given for the sake of comparison with the situation in Europe.

4.1 Lectures & courses in Japan

4.1.1 JAIST Japan Advenced instutut pf Science and technology

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Hideyki Mutara	Organic electronics	Msc. School of Materials Science - Department of Materials Science, Materials Characterization and Device	Lectures		
Aim/Contents	• Introduction to organic semiconductors • Molecular & crystalline structure, liquid crystals • Theoretical models for the description of the electronic structure • Charge transport in organic semiconductors • Optoelectronic devices (OLEDs, plastic solar cells ...) • Field effect transistors				

4.1.2 Kyushu University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Tanemasa Asano	Large Area Electronics	MSC. Department of Electrical Engineering and computeur sciences	Lectures		
Aim/Contents					

4.1.3 Ryukyu University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
T. Nogushi	Large Area Electronics	MSC. Department of Electrical and Electronics Engineering, Faculty of Engineering	Lectures		
Aim/Contents					

4.2 Lectures & courses in South Korea

4.2.1 Kyung He University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Jang-Joo Kim	Organic Electronics	MSC	Lectures Lab work	45 hrs	
Aim/Contents	Starting from the understanding of the electronic structure of conjugated molecules and molecular solids, electrical and optical properties of conjugated molecular solids and polymers will be covered in depth. Exciton generation and decay, metal/organic and organic/organic junctions, charge injection, transport and recombination are included. Device physics and recent research trend of organic optoelectronic devices such as organic light emitting diodes, organic thin film transistors, and organic photovoltaic cells will be introduced. Contents: • Introduction to Course (outline, objective, conjugated molecules) • Electronic structure of organic semiconductors • Optical properties (Absorption, Emission, Energy transfer) • Electrical Properties (Space charge limited current, Trap charge limited current, Transport Model) • OLED (History, Structure and Fabrication process, Degradation) • OTFT • Photovoltaic Cell				

4.2.2 Sungkyunkwan University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Young Hee Lee	Organic Electronic and Photonic	MSC Physic and Power department	Lectures		
Aim/Contents					

4.2.3 Seoul National University

Person in charge	Title of the lecture	Level	Teaching methods	Duration	ECTS
Mi Koo Han	Electronic for display	MSC Electrical Engineering department	Lectures Lab work		

5 Training actions under PolyNet and PRODI

5.1 Summer schools supported by PolyNet

Two summer schools have been organized under the auspices of PolyNet. Both were side events of conferences, held in Greece (International Summer School on Nanosciences and Nanotechnologies, ISSON) and in France (International Conference on Organic Electronics, ICOE). The details of each summer school is given below.

5.1.1 ISSON 2010

ISSON was a parallel event of the International Symposium on Flexible Organic Electronics held in Halkidiki (Greece) in July 2010. It comprised two parallel schools:

1. Nanomaterials and Nanoscale characterisation (N&N)
2. Organic Electronics.

The latest was composed of 9 lectures. The school gathered 28 attendees from 12 different countries. The main participations were from Greece, Romania and the Czech Republic. The lecturers are listed below.

Prof. G. Malliaras, Ecole des Mines de Saint Etienne, France **"Introduction to Organic Electronics"**

Prof. G. Hadziioannou, Institut Polytechnique de Bordeaux (ENSCBP) / CNRS, France **"A Bottom-Up Approach to Nanoscience and Nanotechnology: Micro- Nano-Structuring of Functional Polymer Materials via Manipulation of the Self-Organization Process of Polymer Blends and Block Copolymers"**

Dr. N. Meyer, **"OVPD® Technology for Organic Electronics"**

Dr. B. Fillon, CEA LITEN, France **"Nanomaterial and nanotechnologies for new energy applications"**

Dr. Th. Kolbuch, Coatema, Germany **"Production Technologies for Large Area Printed Flexible Electronics" Prof. J. Ulanski,** Technical Universirsity of Lodz, **"Unconventional methods of producing flexible organic field-effect transistors"**

Prof. L. Torsi, Universita Degla Studi Di Bari, **"Organic Thin-Film Transistor sensors"**

Dr. C. Gravalidis, Aristotle University of Thessaloniki, **"Thin Films Technology in Organic Electronics"**

Dr. A. Laskarakis, Dr. P. Karagianidis, Aristotle University of Thessaloniki, **"Optical, Electrical and SPM Characterization for Organic Electronic Applications"**

5.1.2 ICOE 2010

The conference was held in Paris, France in June 2010. As a side event, it comprised a one tutorial with three lectures:

Gorge Malliaras, Centre de Microélectronique de Provence, Gardanne, France **"Organic electronics at the interface with biology"**

Jens Pflaum, University of Würzburg, Germany **"Towards molecular thin film electronics:What can we learn from organic single crystals"**

Barbara Stadlober, Joanneum Research, Austria **"High resolution printing of organic electronic devices"**

The tutorial was attended by 137 people (including 93 students) from 19 different countries (including Asia and America). The attendance by students was stimulated by making their registration free of charge.

5.2 Schools organized by PRODI

PRODI is a Coordination Action intended to provide a structured forum for European printing, coating, laser, 'advanced processing' machinery manufacturers, production line integrators, and process measurement and automation industry to work together in improving European excellence and competitiveness in roll-to-roll (R2R) Polymer and Printed Electronics machinery and automation.

PRODI has synergies with several other project proposals in the same area, including PolyNet (NoE), PolyMap (SA), and OPERA (CA). The applicable activities of the four projects have been harmonized under a structure called "the Quadriga".

During the three years of the project, PRODI has organized four courses and workshops:

1. November 24, 2008: "**Bridging the gap between design and R2R technology"** held at IMEC, Leuvne, Belgium.

2. April 22, 2009: **"PRODI Intensive Course and Workshop"** held at the Technical University of Chemnitz, Germany.

3. July 12 - 13, 2010: **"PRODI's Annual Intensive Course"** held at IMEC, Leuven, Belbium.

4. October 4 - 6, 2010 **" PRODI's Workshop and Seminar 2010: Reel-to-Reel Production Systems for OLAE Devices"** held at the Fraunhofer EMTF in Munich, Germany.

Details on the program of the workshops can be found on PRODI's web site at <http://www.project-prodi.eu/events.html>.