Ultra-high Charge Carrier Mobility to Elucidate Transport Mechanisms in Molecular Semiconductors

UHMOB

RECRUITMENT LEAFLET

How does and MSCA-ITN work?[1]

H2020 Marie Skłodowska-Curie Innovative Training Network (MSCA-ITN) action aiming at training a new generation of creative, entrepreneurial and innovative early-stage researchers. The objective behind is to bring together universities, research institutes and other sectors from across the world to train researchers to doctorate level.

UHMob is an MSCA-ITN European Training Network (ETN) which will help researchers to gain experience of different working environments, while developing transferable skills.

Glossary

Term	Definition
Action	Under Horizon 2020, "action" refers to the specific project to be implemented by the beneficiaries.
Early-Stage Researchers (ESRs)	must, at the date of recruitment by the beneficiary, be in the first four years (full-time equivalent research experience) of their research careers and have not been awarded a doctoral degree.
Date of Recruitment	means the first day of the employment of the researcher for the purposes of the action (i.e. the starting date indicated in the employment contract or equivalent direct contract).
Full-Time Equivalent Research Experience	measured from the date when the researcher obtained the degree entitling him/her to embark on a doctorate(either in the country in which the degree was obtained or in the country in which the researcher is recruited), even if a doctorate was never started or envisaged.
Mobility Rule	researchers must not have resided or carried out their main activity (work, studies, etc.) in the country of the recruiting beneficiary for more than 12 months in the 3 years immediately before the recruitment date. Compulsory national service, short stays such as holidays, and time spent as part of a procedure for obtaining refugee status under the Geneva Convention are not taken into account. For international European interest organisations, international organisations, the European Commission's Joint Research Centre (JRC) or an 'entity created under Union law', recruited researchers must not have spent more than 12 months in the 3 years immediately before the recruitment date at the same appointing organisation.
Coordinator	the beneficiary which is the central contact point for the Research Executive Agency (REA) and represents the consortium towards REA.
Beneficiaries	the legal entities that sign the Grant Agreement and have the responsibility for the proper implementation of the action. They contribute directly to the implementation of the research, transfer

[1] Source: https://ec.europa.eu/research/mariecurieactions/actions/research-networks_en

Term	Definition
	of knowledge and training activities by recruiting, supervising, hosting, training and seconding researchers.
Partner Organisations	contribute to the implementation of the action, but do not sign the Grant Agreement. Partner organisations do not employ the researchers under the action.
Secondment	is a period of research training with another beneficiary, its entities with a capital or legal link, or a partner organisation implemented to further enrich the training experience of a researcher.
European Charter and Code for Researchers	Commission Recommendation of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers, C(2005)576 of 11March 2005.

The UHMob team

The UHMob Team comprises 10 beneficiaries who will host the ESR and 5 partner organisations which will provide support for the successful implementation of the action.

Beneficiaries

	Organisation name	Short Name
Beneficiaries	Universite Libre de Bruxelles	ULB
	Universite de Mons	UMons
	The Chancellor Masters and Scholars of the University of Cambridge	UCAM
	Université de Strasbourg	UNISTRA
	Technische Universitaet Graz	TUGraz
	Humboldt-Universitaet zu Berlin	UBER
	Max-Planck-Gesellschaft zur Forderung der Wissenschaften Ev-P	MPG
	Agencia Estatal Consejo Superior Deinvestigaciones Cientificas	CSIC
	POLYCRYSTALLINE S.P.A.	PCL
	BASF	BASF
Partner Organisations	ARTTIC	ARTTIC
	University of Amsterdam	UVA
	Kyoto University	KU
	University of Bologna	UNIBO
	Universitat Autònoma de Barcelona	UAB

Purpose of this document

This recruitment leaflet intends to advertise the opening of 15 doctoral positions at major European universities and to inform applicants of the UHMob project and the recruitment process.

No discrimination policy

UHMob is committed to having a fair and discrimination-free recruitment process. Candidates will be selected on the sole criteria of academic excellence with no reference to gender, ethnical origins, sexual orientation, or religion. The principles set out in the European Charter for Researchers and in the Code of Conduct for the Recruitment of Researchers apply.

Project overview

UHMob for Early-Stage Researchers

UHMob is a multi-site European Training Network (ETN) aimed at enabling multidisciplinary and cross-sectoral training and research on a hot topic at the interface between Materials Chemistry, Nanoscience, Spectroscopy, Crystallography, Physics, and Optoelectronics.

The objective of UHMob is to widen the career perspectives of Early-Stage Researchers (ESRs), in the field of organic electronics by increasing their employability in both academic and industrial sectors. Six universities, two research centres, and two companies in Europe will join their forces to train 15 ESR. The University of Bologna, the University Autonoma de Barcelona and the University of Amsterdam will be involved as partner organisations and as such deliver degrees for 6 ESR and contribute to their training. The University of Kyoto, that has unique expertise, will complement the consortium and will further increase the international dimension of the UHMob. The intensive training program that takes advantage of secondments, coupled with the recent scientific breakthroughs of UHMob partners offers ESRs the unique opportunity to carry research at the forefront of science.

UHMob for Science

The scientific objective of UHMob is to gain a fundamental understanding of charge transport mechanisms in molecular semiconductors. To this goal, best-performing and well-characterized materials will be studied by a complementary set of methods, including field effect transistors but also optical methods such as terahertz spectroscopy, field-induced time-resolved microwave conductivity. UHMob will also explore the coupling of molecular semiconductors with the vacuum electromagnetic field, that is a radically new physical concept holding great promises to modulate optoelectronic properties of materials.

Overview of the consortium

The consortium is composed of ten beneficiaries and four partner organisations selected for their world-recognized expertise and unique equipment. Among the ten beneficiaries there are:

- Six universities,

- Two research centres,
- Two industrial organisations, including an SME and a large chemical company.

The 14 partners conduct cutting-edge research in their sub-disciplines and are used to train ESRs.

The research complementarities between partners are multiple and are explained as it follows:

ACADEMIA AND INDUSTRY. Both industrial partners (PolyCrystalline & BASF) not only perform applied research but also have the required expertise to protect and valorise IPR into business. PolyCrystalline is a high-technology SME that provides research services to a large number of pharmaceutical companies. BASF is the largest chemical company in the world. Its activities encompass all chemical business. The nine remaining partners are from academia and are all reputed for their fundamental research and scientific breakthroughs. The association between academic and industrial expertise is at the heart of the cross-sectoral research and training programme.

EUROPE AND ASIA. All ten beneficiaries are from Europe and share a common culture that shows in the way to conduct research or do business. The Kyoto University, as a partner organization, will bring a radically different cultural approach blended in a tradition of scientific excellence.

THEORY AND EXPERIMENTS. University of Mons and BASF are theory groups able to design the best performing materials and rationalize complex phenomena from first principles. The nine other partners develop experimental approaches covering a large set of expertise: synthetic chemistry, materials characterization, measurement of structural and thermodynamic data, determination of energy levels, spectroscopic characterization of molecular and supramolecular properties, processing of materials into highly ordered thin films, investigation of electromagnetic properties, and coupling with the vacuum field.

SYNTHESIS AND CHARACTERIZATION. The consortium offers a perfect balance between expertise needed for semiconductors synthesis (ULB) and the measurement of physical parameters (8 other partners). The Université Libre de Bruxelles has scientific knowledge in organic chemistry and a considerable laboratory know-how required to synthesize semiconductors. This expertise is fundamentally different from the one needed for the measurement of physical parameters that will be carried out by the eight other partners conducting experimental research.

MATERIALS AND MEASUREMENTS. Four partners (ULB, UMons, CSIC & BASF) will mostly bring a materials approach, i.e. design, synthesis, and processing of materials to obtain the best performances. Seven partners (UCAM, UNISTRA, TUGraz, UBER, MPI-P, PCL & KU) will chiefly contribute with measurement of structural, thermodynamic, energetic, electric, optical, and dynamic properties. Materials performances and physical measurements are so intimately linked that they cannot be dissociated.

SHORT AND LARGE. Charge transport will be investigated at short length- and time- scales by FI-TRMC (KU) & TRTS (MPI-P). In a complementary way, OFETs (UCAM, UNISTRA & CSIC) and Hall effect (UCAM) will allow probing charge transport at larger length- and time- scale.

UHMob has been designed to offer comprehensive training offering scientific knowledge, as well as the complementary technical and research skills. The various profile of the partners will naturally lead them to deliver different training in transferable skills.

Furthermore, ARTTIC will train ESRs in transferrable skills, in particular, project management, grant proposal writing, IP management and communication towards the public. ARTTIC will also carry out specific communication activities in particular towards the public, as well as support the project management.

Description of the individual doctoral project of the 15 ESRs

ESR1					
Hired by	ULB	**Degree delivered by**	ULB		
Supervisor	Yves Geerts				
Project title	Design and synthesis of molecular semiconductors resilient to energetic disorder				
Objectives	To develop a new generation of molecular semiconductors with a room temperature μ > 100 cm2/Vs.				
Expected results	It is well-established from temperature-dependent charge transport measurement that mobility values are limited by structural disorder, inducing energetic disorder. Low-temperature measurements afford mobility ranging from 100 to 300 cm^2/Vs. It is, however, possible to engineer molecular and crystal structure of semiconductors to reach situations in which electronic coupling between adjacent molecules cause a restricted energetic disorder. It is intended to design by theory such materials, to synthesise them in sufficient amount and purity, and to distribute them for charge transport measurements.				
Secondment n°1	**Host:** UMons	**Supervisor**	D. Beljonne	**Duration**	3 months
	The purpose is to optimize molecular geometry, calculate frontier orbitals and electronic coupling as a function of the relative position of molecules in dimers.				
Secondment n°2	**Host:** KU	**Supervisor**	S. Seki	**Duration**	6 months
	ESR1 will use FI-TRMC to measure charge transport properties at local scale.				
Desired profile of candidates	Synthetic chemist with a sound knowledge of organic chemistry, physical chemistry, and materials sciences.				

ESR2					
Hired by	ULB	**Degree delivered by**	ULB		
Supervisor	Yves Geerts				
Project title	Design and synthesis of molecular semiconductors adapted to couple with the vacuum field				
Objectives	To develop a new class of molecular semiconductors that to couple with the vacuum field and that μ > 100 cm^2/Vs.				
Expected results	The coupling with the vacuum field is a totally new concept in the field of molecular semiconductors that has recently been demonstrated for some chromophores. The concept needs now to be extended to other class of strongly absorbing p- and n-type semiconductors. Optimized materials will enable to reach higher charge carrier mobility but will also enable a deeper understanding of the physics of transport at both experimental and theoretical levels.				
Secondment n°1	**Host:** UNISTRA	**Supervisor**	T. W. Ebbesen	**Duration**	3 months
	The purpose is to get used to the concept of vacuum coupling, to fabricate optoelectronic devices and to understand with molecular and supramolecular properties must be tailored.				
Secondment n°2	**Host:** BASF	**Supervisor**	H. Mangold	**Duration**	3 months
	The purpose is to assess the industrial potential of semiconductors tailored to couple with vacuum field.				

ESR2	
Desired profile of candidates	Synthetic chemist with a sound knowledge of organic chemistry, physical chemistry and materials sciences.

ESR3					
Hired by	UMons		**Degree delivered by**	UMons	
Supervisor	David Beljonne and Jérôme Cornil				
Project title	Theoretical evaluation of the key molecular parameters governing charge transport				
Objectives	Quantum-chemical calculations (for electronic properties) and force-field approaches (for nuclear dynamics) will be combined to assess a series of key molecular parameters for charge transport in the target compounds, in particular the degree of molecular motion induced by the lattice vibrations, the internal reorganization energy upon charging, electronic bandwidths in the crystals, the transfer integrals and their fluctuations induced by the nuclear dynamics, the coupling of the transfer integrals to the individual lattice modes (non-diagonal electron-phonon coupling), and the resilience of the transfer integrals to strain effects.				
Expected results	Find strategies to minimize the degree of molecular motions to reduce the non-diagonal electron-phonon couplings				
Secondment n°1	**Host:**	UBER	**Supervisor**	N.Koch	**Duration** 3 months
	The scientific objective of this secondment will be to assist the interpretation of the experimental UPS data obtained for the target compounds with the help of quantum-chemical calculations.				
Secondment n°2	**Host:**	UCAM	**Supervisor**	H. Sirringhaus	**Duration** 3 months
	The scientific objective will be to confront for target compounds the nuclear dynamics inferred from force-field approaches to that deduced from thermal diffuse scattering measurements.				
Desired profile of candidates	Chemist or physicist with a good knowledge of modern quantum-chemical approaches (in particular Density Functional Theory) and force-field calculations.				

ESR4			
Hired by	UMons	**Degree delivered by**	UMons
Supervisor	David Beljonne and Jérôme Cornil		
Project title	Theoretical evaluation of charge carrier mobilities in molecular crystals		
Objectives	The molecular parameters inferred by ESR3 will be injected into transport models to compute the mobility anisotropy in the crystal structure of the target compounds. Simple transport models assuming either a pure band-like (fully delocalized charges – fast transport) or hopping (charges localized over a single molecule – slow transport) regime will first be applied to evaluate the boundary values of the charge carrier mobility when adopting these two extreme scenarios. The results will then be refined using more sophisticated mixed classical-quantum dynamical schemes recently developed in Mons, with no a priori assumption on charge delocalization.		

ESR4						
Expected results	Find crystal structures maximizing the charge carrier mobilities and confront theory to experimental data.					
Secondment n°1	**Host:**	KU	**Supervisor**	S. Seki	**Duration**	3 months
	The main goal will be to confront the calculated mobility values to corresponding experimental data obtained by FI-TRMC.					
Secondment n°2	**Host:**	MPI-P	**Supervisor**	M. Bonn	**Duration**	3 months
	The main goal will be to assist the interpretation of the THz data by computing the change in the dipole moment linked to charge delocalization with the lattice vibrations.					
Desired profile of candidates	Physical chemist or physicist with background in quantum-chemistry and solid-state physics and skills for programming languages.					

ESR5						
Hired by	UCAM			**Degree delivered by**	UCAM	
Supervisor	Henning Sirringhaus					
Project title	Field effect transistors with ultrahigh mobilities					
Objectives	Microscopic understanding of the electron-phonon coupling of charge carriers in high mobility molecular semiconductors to low-frequency intermolecular vibrations by measuring transport coefficients, such as temperature-dependent mobility, Hall effect, thermopower measurement.					
Expected results	Reliable and robust charge carrier mobility values as a feedback to chemical synthesis and to establish reliable molecular design rules; Understanding of electron-phonon coupling in high mobility molecular semiconductor as a basis for developing the coherent coupling experiments of THz radiation to charge carrier motion (ESR10). The project will be focused on translating advances in fundamental understanding into tangible improvements in device performance. This will require careful device optimisation taking into account practical requirements for scalable industrial manufacturing.					
Secondment n°1	**Host:**	MPI-P	**Supervisors**	Dr. E. Backus Prof. M. Bonn	**Duration**	4 months
	The purpose is to develop the use of second harmonic generation to probe structural changes at the dielectric/semiconductor interface and to apply the understanding of dynamic disorder effects to the coherent THz coupling experiments of ESR10.					
Secondment n°2	**Host:**	KU	**Supervisor**	S. Seki	**Duration**	3 months
	The purpose is to understand how mobility values extracted from FI-TRMC and transistor / Hall-effect measurements relate to each other.					
Desired profile of candidates	Physicist, chemist or materials scientist with an interest in semiconductor device physics and materials science.					

ESR6			
Hired by	UNISTRA	**Degree delivered by**	UNISTRA
Supervisor	Thomas W. Ebbesen		
Project title	Organic semiconductors under light-matter strong coupling		

ESR5						
Objectives	Improving the fundamental understanding of conductivity enhancement under strong coupling and optimization of charge-carrier mobility through the control of both material and optical design for optimal device architecture.					
Expected results	Highly ordered organic semiconductors provided by partners will be integrated into optical resonators tailored first by numerical simulations and then by fabrication. The plasmonic structures will be fabricated by focused ion beam. Fabry Perot cavities prepared with metallic and/or dielectric mirrors using sputtering techniques will also be tested. The samples will be characterized for strong coupling by measuring the optical properties of the finished devices. Conductivity and photoconductivity in the three-terminal devices will be compared with those of uncoupled devices. Various semiconductors, both n- and p-type, will be investigated. The results of such studies will enable the optimization of the field-effect mobility enhancement under strong coupling with the vacuum field.					
Secondment n°1	**Host:**	MPI-P	**Supervisor**	M. Bonn	**Duration**	2 months
	The purpose is to learn the terahertz spectroscopy.					
Secondment n°2	**Host:**	BASF	**Supervisors**	H. Mangold P. Erk	**Duration**	2 months
	The purpose is to learn device fabrication in regard to implementing strongly coupled semiconductors in industrial systems.					
Desired profile of candidates	Master's degree in chemistry, previous experience in the characterization of samples by spectroscopic techniques (FTIR, fluorescence, etc.) and by electrical measurements; experience with preparation of optical cavities and strongly coupled system is a big plus.					

ESR7			
Hired by	UNISTRA	**Degree delivered by**	UNISTRA
Supervisor	Paolo Samorì		
Project title	Self-assembly and multiscale characterization of structures and interfaces		
Objectives	Optimizing the molecular self-assembly at surfaces forming low-dimensional nanostructures exhibiting high μ values.		
Expected results	Optimization of self-assembly by using various methods (including LB and ink-jet printing) and post-processing (SVA, thermal annealing). Tailoring interfaces (lowering roughness and optimizing energetics) also to improve wettability via chemisorption and physisorption. Multiscale investigation of the self-assembled structures by SPM (AFM, STM, C-AFM, KPFM). Complementary studies of the chemical composition (by XPS, TGA, FTIR), spectroscopical properties (absorption, fluorescence, fluorescence microscope, micro-Raman), energetics (ambient PS, macroscopic KP, KPFM), electrical characterization in 2-terminal (Eutectic Ga/In drop-based junctions , C-AFM), 3-terminal (OFETs) and 4-terminal devices under different environmental conditions (glove box, air) at variable temperature (down to liquid N_2), also under monochromatic light irradiation (photo-conductivity). Special focus will be given on the correlation between the degree of crystallinity		

ESR7						
	within the film and, interface tailoring with the ultimate goal of fabricating electrical devices with optimized performance.					
Secondment n°1	**Host:**	CSIC	**Supervisor**	M. Mas-Torrent	**Duration**	3 months
	The secondment will start at month 12 and will have a duration of 3 months. The purpose is to improve the chemical tailoring of interfaces.					
Secondment n°2	**Host:**	BASF	**Supervisor**	H. Mangold P. Erk	**Duration**	3 months
	The secondment will start at month 24 and will have a duration of 3 months. The purpose is to optimise devices, under industrial conditions.					
Desired profile of candidates	Master's degree in materials science or chemistry, and previous experience in the preparation and characterization of self-assembled organic thin films on surfaces by ambient and ultra-high vacuum SPM (AFM, STM), XPS, UPS, GIXRD, profilometer, etc.					

ESR8			
Hired by	TUGraz	**Degree delivered by**	TUGRaz
Supervisor	Roland Resel		
Project title	Surface-induced crystal structures: origin, stability and applicability		
Objectives	Discovery of new polymorphs which exists only within thin films (surface induced phases); find basic features of these new polymorphs, identify basic principles on their formation, check the suitability of surface-induced phases for transistor performance.		
Expected results	preparation parameters which cause the formation of a surface-induced phases, structure of sub-, monolayer and multilayer films for determination of film formation, clarify the role of a wetting layer for the formation of a surface-induced phase, crystal structure solution of surface-induced phases, thermodynamic stability from temperature dependent investigations, thin film morphologies as input for device characteristics.		
Secondment n°1	**Host:** UMons	**Supervisor** J. Cornil	**Duration** 3 months
	The objective is to learn theoretical modelling by Molecular Dynamics simulations and DFT calculations to determine molecular packing using the crystallographic unit cell as an input parameter.		
Secondment n°2	**Host:** PCL	**Supervisor** C. Capuccini	**Duration** 3 months
	TESR8 will learn techniques to generate a maximum of bulk polymorphs from a given compound.		
Desired profile of candidates	Education in chemistry, material science or physics with the basic knowledge on solid state physics.		

ESR9			
Hired by	UBER	**Degree delivered by**	UBER
Supervisor	Norbert Koch		
Project title	Electronic band structure and interface level alignment		

Objectives	Determine the electronic band structure of molecular single crystals with high mobility and the energy level alignment between the organic semiconductors and electrodes as well as dielectrics by photoelectron spectroscopy.
Expected results	The ionisation energy and electron affinity of molecular thin films and single crystals (as a function of molecular orientation at the surface) determined by the ESR will serve as important parameters for molecular design-feedback. The experimental methods ultraviolet photoelectron spectroscopy (UPS) and inverse photoelectron spectroscopy (IPES) will be optimized for excluding sample radiation damage. The energy level alignment and its underlying mechanisms, at interfaces between the molecular solids and metal contacts as well as dielectrics will be determined by UPS and X-ray photoelectron spectroscopy (XPS) and forwarded to device-related tasks. The electronic band structure of highly ordered films and single crystals (selection based on highest achieved carrier mobility) will be determined by angle-resolved photoemission spectroscopy (ARUPS). From band curvature, the ESR can estimate the effective mass of charge carriers and the coherence length of their wave-packet. This length-scale dependent mobility assessment bridges the understanding of mobility data from THz and OFET measurements, as well as can directly be compared to theory results.
Secondment n°1	**Host:** UNISTRA **Supervisor** P. Samorì **Duration** 3 months The aim is that the ESR obtains expert training in the fabrication and characterization of devices based on high mobility molecular materials, which will further contribute to the understanding of the requirements for UPS/XPS/IPES experiments. Moreover, this secondment establishes cross-node sample fabrication procedures.
Secondment n°2	**Host:** UMons **Supervisor** D. Beljonne **Duration** 3 monhs The purpose is to train the ESR in quantum chemistry methods to describe the band structure of molecular single crystals by theory, which will further the interpretation of experimental data and will form a more comprehensive understanding of band structures in the consortium.
Desired profile of candidates	Physicist with sound knowledge of solid-state physics and electronic structure of solids, as well as demonstrated experience in performing experiments with ultrahigh vacuum systems.

ESR10			
Hired by	MPI-P	**Degree delivered by**	University of Amsterdam
Supervisor	Mischa Bonn		

Project title	Mechanism and efficiency of conductivity in high-mobile organics using Terahertz spectroscopy				
Objectives	To correlate molecular structural arrangement to charge carrier mobilities, Time-resolved Terahertz (THz) spectroscopy will be employed to establish the mechanism and efficiency of electron and hole transport in the bulk material. THz spectroscopy allows to identify the primary product of photo-excitation in the material (excitons vs. polarons) and to determine their relative lifetimes. Measurements will be performed on differently processed pure materials and on devices, to correlate 'best' and 'actual' performance, and identify bottlenecks for device improvement.				
Expected results	Insights into the fundamentals of charge carrier generation, motion and recombination in molecular semiconductors with the highest charge carrier mobility. Particularly, determining at which length-scales the coherence of charge transport (band-like mechanism) is lost to propose strategies to extend it to distances superior to the typical channel length of OFETs. First demonstration of a collective vibrational mode (Froehlich condensation) induced by an external electromagnetic stimulus, in molecular semiconductors.				
Secondment n°1	**Host:**	UNISTRA	**Supervisor**	T. W. Ebbesen	**Duration** 3 months
	ESR10 will create structures suitable for studying strong THz field-material coupling, to identify polaron-polaritons and, possibly, Froehlich condensates, and explore the implementation of these concepts in devices.				
Secondment n°2	**Host:**	KU	**Supervisor**	S. Seki	**Duration** 3 months
	ESR10 will use FI-TRMC to measure charge transport properties at the local scale, and correlate the results to the high-frequency terahertz measurements performed at MPI-P.				
Desired profile of candidates	Physicist or physical chemist with experience in spectroscopy or with semiconductors.				

ESR11			
Hired by	MPI-P	**Degree delivered by**	University of Amsterdam
Supervisor	Ellen Backus		
Project title	Molecular & electronic structure & conductivity specifically at interfaces studied using non-linear optical tools		
Objectives	To elucidate, using highly surface-specific nonlinear optical methods (SGH & SFG), the interfacial electronic properties and the mobility of charges in the molecularly thin region near the metal or dielectric-semiconductor interface. Experiments will be performed on model systems on different supports, and in devices, where correlations between interfacial molecular organization – affected by e.g. deposition and annealing methods – and device performance will be investigated.		
Expected results	Fundamental understanding of the role of interfaces on the arrangement of the molecular conductor and the effect of that arrangement on interfacial charge carrier mobility and energy levels. Correlation between polymorphism in bulk and at interface.		
Secondment n°1	**Host:** UBER	**Supervisor**	N. Koch **Duration** 4 months
	ESR11 will correlate the optical results to those of electronic spectroscopy.		

ESR11						
Secondment n°2	**Host:**	TUGraz	**Supervisor**	R. Resel	**Duration**	2 months
	ESR11 will correlate the inferred structural and energetic properties from optical spectroscopy to direct measurements of the interfacial structure by x-ray scattering methods.					
Desired profile of candidates	Physicist or physical chemist with experience in spectroscopy or with semiconductors.					

ESR12			
Hired by	CSIC	**Degree delivered by**	University Autonoma of Barcelona
Supervisor	Marta Mas-Torrent		
Project title	Solution-processing of organic semiconductors for achieving high mobility and reproducibility		
Objectives	To develop processing techniques compatible with roll-to-roll fabrication processes in order to realize high mobility thin films of benchmark semiconductors as well as of the novel organic semiconductors synthesised at UHMob. To promote solution wettability, blends of the organic semiconductors with polymers will be employed. Significant efforts will be placed on the control of the thin films morphology and crystallinity. A large number of devices will be fabricated and tested to ensure high reproducibility, crucial for their transfer to industry.		
Expected results	A major hurdle to the industrialisation of OFETs is the poor control of crystallisation giving rise to poor device to device reproducibility. The development of processing methods allowing to better control crystallization conditions for narrower transistor characteristics is expected from solution shearing processing. Fabrication on flexible substrates will also be pursued, which is desired for low cost and large area industrial applications.		
Secondment n°1	**Host:** TUGraz	**Supervisor** R. Resel	**Duration** 3 months
	The objective will be the structural characterization of the organic semiconductor thin films prepared at CSIC, mainly by grazing incidence X-ray diffraction (GIXD).		
Secondment n°2	**Host:** UBER	**Supervisor** N. Koch	**Duration** 3 months
	The purpose here will be to characterise the organic semiconductor thin films by spectroscopic means in order to gain insights into the energy level alignment of the organic semiconductor/metal interface, as well as information on the film morphology (i.e., vertical phase separation in blends of organic semiconductors).		
Desired profile of candidates	Degree in Physics, Chemistry, Materials Science or similar and related master's degree. Experience in molecular materials or electrical characterisation will be highly valued.		

ESR13			
Hired by	PCL	**Degree delivered by**	University of Bologna
Supervisor	Enrico Modena and Lucia Maini		
Project title	Study of the bulk polymorphism of best performing molecular semiconductors		

Objectives	To determine the number and the relative stability of polymorphs of selected molecular semiconductors. Identification of molecular features and crystal growth conditions favouring robustness against polymorphism.				
Expected results	Charge carrier mobility is a material property that results from chemical structure and solid-state packing. In this context, it is crucial to determine the polymorphs of best-performing molecules to identify and to protect intellectual property rights.				
Secondment n°1	**Host:**	ULB	**Supervisor**	Y. Geerts	**Duration** 3 months
	The purpose is to use temperature gradient processing developed at ULB to investigate if forced non-equilibrium conditions allows obtaining new polymorphs, not observed with more traditional methods.				
Secondment n°2	**Host:**	CSIC	**Supervisor**	M. Mas-Torrent	**Duration** 6 months
	The purpose is to use solution shearing processing techniques available at CSIC to explore the occurrence of non-equilibrium polymorphs. If any, ESR13 will also fabricate OFETs to evaluate the charge transport properties of the novel polymorphs.				
Desired profile of candidates	Degree in chemistry or material science with knowledge of solid-state characterization, X-Ray diffraction and with basic knowledge of organic chemistry				

ESR14			
Hired by	PCL	**Degree delivered by**	University of Bologna
Supervisor	Enrico Modena and Lucia Maini		
Project title	Critical study of bulk and surface-induced polymorphism		
Objectives	To compare in a critical way bulk and substrate-induced polymorphism for best-performing semiconductors. To rationalize results in terms of first principles and to link them to nucleation and growth phenomena.		
Expected results	Over the years, PCL has gained unique knowledge on bulk polymorphism of molecular crystals. Substrate-induced polymorphism is largely observed for molecular semiconductors, but its origin remains unknown, as pointed out recently by a review article of TUGraz. UHMob will capitalize on this large knowledge, partially unpublished, to gain a fundamental understanding of the polymorphism of molecular semiconductors. It is anticipated that this knowledge will help to devise strategies to control, and even predict, the occurrence of polymorphism of molecular semiconductors in operating OFETs.		
Secondment n°1	**Host:** TUGraz	**Supervisor** R. Resel	**Duration** 6 months
	The purpose is to transfer knowledge on substrate-induced polymorphism and to get trained on diffraction methods to identify it and on methods to solve crystal structures from GIWAXS data.		
Secondment n°2	**Host:** UCAM	**Supervisor** H. Sirringhaus	**Duration** 3 months
	ESR14 will study polymorphism in operating OFETs, i.e. phase transitions that could result from charge transport.		
Desired profile of candidates	Degree in chemistry or material science with knowledge of solid-state characterization, X-Ray diffraction and with basic knowledge of organic chemistry		

ESR15					
Hired by	BASF	**Degree delivered by**	University of Strasbourg		
Supervisor	Hannah Mangold, Peter Erk, and Thomas W. Ebbesen				
Project title	Correlation of electronic structure, optical properties and charge transport in organic semiconductors				
Objectives	Analyze the effects of molecular and aggregate structure on the optical properties of organic semiconductors and correlate them with charge transport. Evaluate emerging class of materials and fabrication methods adapted to coupling with vacuum states.				
Expected results	ESR15 will be exposed to the innovation programme of BASF aiming at high performance materials for electronic applications. This includes the design, synthesis and characterization of materials and the fabrication and characterization of complex optoelectronic devices. He/she will fabricate optoelectronic devices with the aim to exploit new materials (semiconductors with low energetic disorder) and new physical concepts (coupling with vacuum field, Frohlich condensation) and to assess their usefulness in an industrial context. This will be done in close collaboration with other partners, notably ULB, UCAM, UNISTRA, UBER, MPI-P, CSIC, and KU.				
Secondment n°1	**Host**	UNISTRA	**Supervisor**	T. W. Ebbesen	**Duration** 3 months
	The purpose is to get familiar with the concept of coupling with the vacuum field. ESR15 will bring with him/her the best materials from BASF				
Secondment n°2	**Host:**	UCAM	**Supervisor**	H. Sirringhaus	**Duration** 3 months
	The purpose is to be trained in fabricating high-quality single crystal OFETs for reproducible measurements of the highest charge carrier mobilities.				
Desired profile of candidates	Science or engineering background and show high levels of drive and creativity to design and explore technology driven solutions.				

Recruitment process

Consent:

By applying candidates agree that all UHMob partners have access to their personal data, for the purpose of the project.

Eligibility criteria:

1) To have obtained or to be about to obtain a Master's degree (or a title at equivalent level) in chemistry. At the day of hiring, applicants must have been awarded a Master or equivalent degree.
2) To be in the first 4 years (full-time equivalent research experience) of their research careers.
3) Not to have been awarded a doctoral degree.
4) Not to have resided or carried out their main activity (work, studies, etc.) in Belgium for more than 12 months in the 3 years immediately before the recruitment date (Mobility Rule).
5) Applications must be written in English.
6) Application must be complete.

Additional eligibility criteria might be set by institutions that deliver doctoral diplomas.

Application file:

1) A letter of motivation referring to the targeted ESR Vacancy, explaining why you apply for this position and how a PhD would suit your career objectives?
2) A detailed CV including publications (if any)
3) Two reference contacts

How to apply: submit your application by email to uhmob-recruitment@eurtd.com

The deadline for application is August 15, 2019. Applications will be evaluated in a continuous way and positions will be filled in as soon as possible