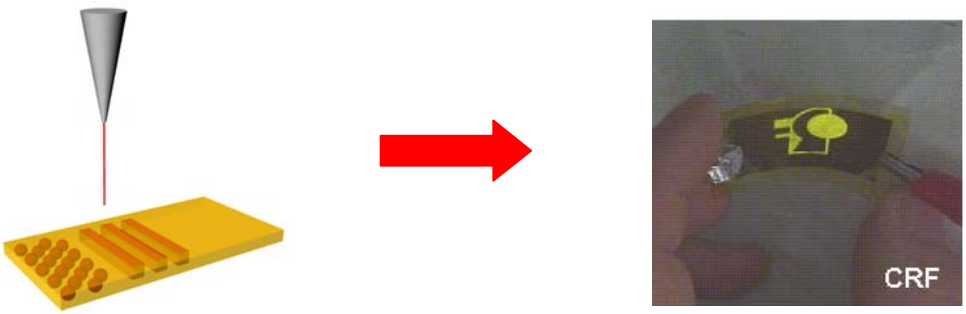
3.1 Publishable summary

Description of project context and objectives

The main objective of this project is the manufacturing of an Organic Light Emitting Diode (OLED) and Transistor (OLET) using a direct laser micro-patterning – (DLP).
The laser action on a polymeric matrix "writes" patterns on the polymer formed by an inorganic nanomaterial. This new method is designed to produce OLED/T based on semiconductor/polymer nanocomposites emission without using lithographic processes.
The interest of this project rely on the advantage that the methodology and materials can bring to the new solid state lightening (SSL) area.
In fact the organic SSL suffers of a short life of materials that can be enhanced by adding inorganic centers, i.e. QDs, as light emitters. Another advantage is due to the methodology itself that uses the laser as way of patterning instead of lithography that needs more steps and cost consuming processes from the industrial point of view.
The OLED/T realisation implementing the laser technology needs three main steps to be accomplished: i) the development of suitable materials, ii) the optimisation of the laser patterning and iii) the OLED/T manufacturing with the materials and laser technologies set up.
The material synthesis comprises both the polymer synthesis and QDs precursors development. The synthesis of the two materials alone is not sufficient to accomplish the task because these two components have to be mixed and thermally treated in order to attain the desired nanocomposite. Their effect will be maximised enhancing their interaction modifying the polymers in order to maximise the QDs emission.
The development of direct laser patterning (DLP**)** technology on polymeric matrices needs the set up of different laser sources to stimulate the synthesis of the nanocomposites. This point will be considered to be achieved if a nanocomposite is obtained by means of DLP. The technological advance in this case is that in a single step the nanocomposite is ready to be used where it is needed (regioselectivity);
The device manufacturing will be finally implemented on the basis of the developed materials and laser technology. The first issue toward this task consists in the preliminary realisation of a light emitting device formed by polymers obtained in the first stage. Then the development of a OLED/LET by means of DLP instead of the current methods will be set up.

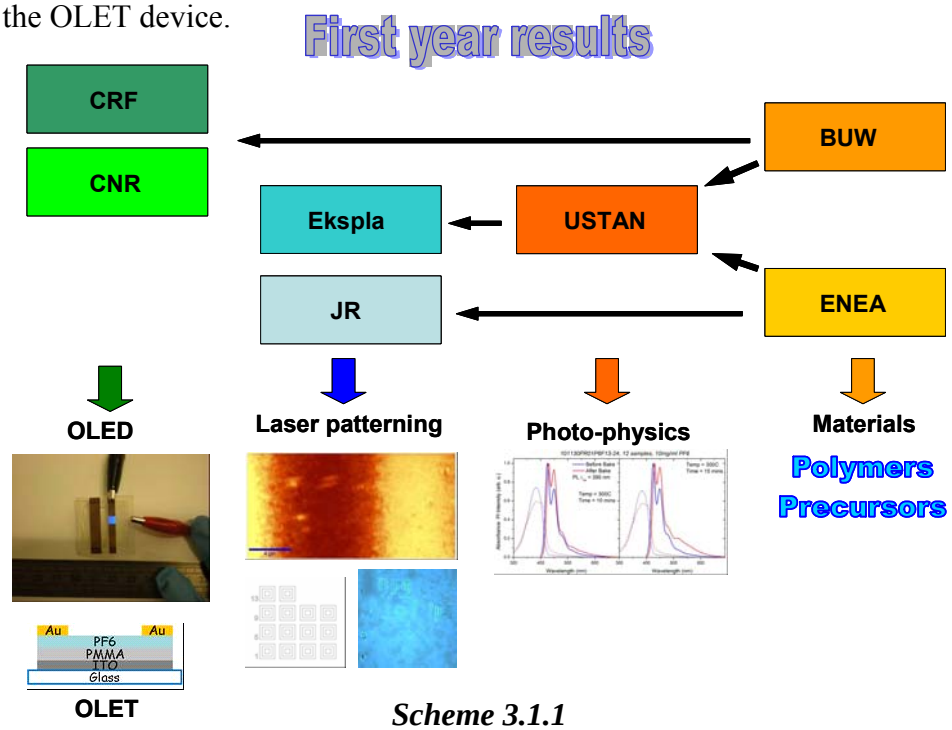


The laser source "write" on the substrate, i.e. the polymer/precursor film over the OLED/T device writing the icon desired.

Description of the work performed since the beginning of the project and the main results achieved so far

During the first year of work on LAMP project the main effort was carried out in the materials synthesis, nanocomposite films formation and the materials photo-physical characterisation. An initial work on direct laser patterning has been also started and in parallel the groups dealing with the OLED/T manufacturing began their work on device realisation with the materials set up during this time.
The materials synthesis is divided in two main areas: polymer synthesis (BUW team) and precursors/quantum dots (QDs) synthesis (ENEA team).
In parallel to the synthesis the USTAN team started the photo-physical study of the polymer/precursor film and their photo-physical properties before and after baking.
The laser manufacturing teams (Ekspla and JR) stated their work on polymers, precursors and a blend of them to test the formation of the nanocomposite upon the laser action. The two laser groups study the action of three different laser systems on the samples: Ekspla worked with a 532 nm and 1064 nm lasers, while JR set the system at 780 nm.
The teams dealing with the OLED (CRF) and OLET (CNR) manufacturing started their activity testing the polymers synthesised by BUW as suitable material for light emission.
The main results can be summarised as following (see also the scheme 3.1.1):

- The BUW team produced two groups of polymers i.e. a set of modified polyfluorene and a set of polyfluorene copolymers with modification of side chains;
- The ENEA team worked on the synthesis of several QDs precursors and finally selected three metallorganic molecules producing the QDs after thermal treatment;
- The USTAN team on the basis of the best photo-luminescent quantum yield (PLQY) selected a set a of polymer/precursor combinations between the possible combinations between the materials produced by BUW and ENEA;
- Ekspla and JR started to test the laser action on the samples provided by USTAN and ENEA. The laser action on the polymer/precursor film reveals the possibility to remove the film and/or to bleach the polymer. However the QDs luminescence has not been detected after the laser action;
- CRF produced the first OLED with one of the polymers obtained by BUW. CNR tested the polymers on the OLET device.



Scheme 3.1.1

Expected final results and their potential impact and use (including the socio-economic impact and the wider societal implications of the project so far)

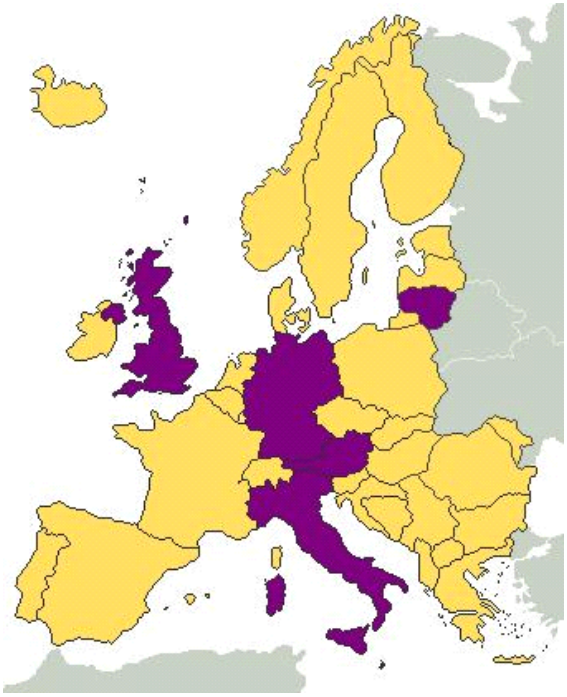
The development of a new concept OLED/T device proposed in this project is based on the combination of three main ideas: i) the development of a novel organic/inorganic nanostructured material, ii) laser patterning of polymer/inorganic films and iii) the exploitation of the materials and laser patterning on a OLED/T devices.
The expected output of the LAMP project is an OLED/T device with an extended lifetime coupled with a decreased power consumption of about 20% and an easier industrial process for patterning realisation (no photo-lithographic and evaporation methods).
Each of the significant output of the project will clearly find an immediate use in several application sectors and will have a huge impact at European level and worldwide resonance.
The strategic exploitation areas forecasted for the LAMP project outcome are:

- Luminous icons and/or info panels for automotive applications;
- New devices for general lighting and in particular Solid State Lightening (SSL);
- Displays (arrays of OLED/T realised with lasers).

The LAMP consortium gathers 7 groups belonging to five different countries, and it has been built with the scope to cover not only the expertise needed for the project, namely materials synthesis, materials laser processing and device manufacturing, but also to recruit research groups actively working in the field of LED research and manufacturing.

Partners list

Organisation name	short name	Country
Italian National Agency for New Technologies, Energy and Sustainable Economic Development	**ENEA**	**Italy**
University of Wuppertal (Institute for Polymer Technology)	**BUW**	**Germany**
Centro Ricerche Fiat	**CRF**	**Italy**
Ekspla UAB (SME)	**Ek**	**Lithuania**
National Research Council	**CNR**	**Italy**
Organic Semiconductor Centre (School of Physics and Astronomy University of St. Andrews)	**USTAN**	**United Kingdom**
Joanneum Research Forschungsgesellschaft mbH	**JR**	**Austria**



For any additional information it is possible to look at the project web site at the following link:

www.lamp-project.eu