MIcro Quantum Dot-Light Emitting Diode/Organic Light Emitting Diode - DIrect patterning

THE MILEDI PROJECT

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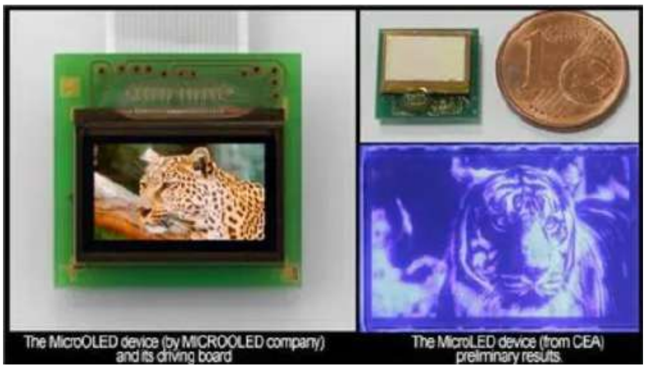
FRANCESCO ANTOLINI

ENEA – Italian National Agency for New Technologies, Energy and Sustainable Economic Development

The MiLEDI (https://www.miledi-h2020.eu/) project starting idea is to demonstrate that the direct laser patterning technology is suitable to obtain patterns of quantum dots (QDs) with different color emissions. Within the project, this principle is then exploited for the manufacturing of the Red Green and Blue (RGB) color conversion filters for micro Quantum Dots Light Emitting Diodes/Organic Light Emitting Diodes (micro-QD-LED/OLED) displays.

Francesco Antolini, the Coordinator of the project, says that “the quantum dots and laser are powerful tools in research and industry. Harnessing their potential by forming colored patterns of QDs over micro-LED/OLED arrays is of great importance for the value chain of the display industry”. This ambitious goal is balanced by the introduction of photolithography as well-known benchmark technology to evaluate direct laser patterning.



The MicroOLED device (by MICROOLED company) and its driving board

The MicroLED device (from CEA) preliminary results

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THE LASER AS A TOOL TO PATTERN NANOMATERIALS

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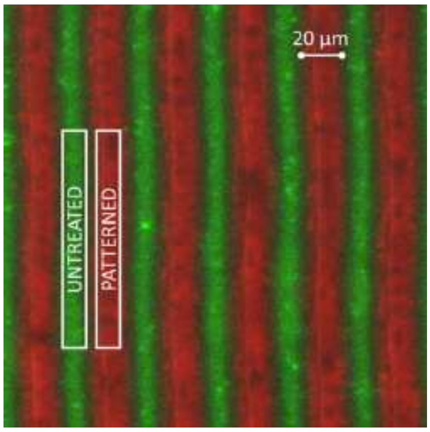
LEONARDO ORAZI

Changing and adjusting the optical properties (color) of quantum dots (nanoparticles) generated with a laser source within a polymer matrix is one of the results of a study conducted by ENEA, UniMORE and TUD in the context of MiLEDI project.

The results of this goal were recently published in Advanced Optical Materials (https://doi.org/10.1002/adom.202200201) and Nanomaterials (https://www.mdpi.com/2079-4991/12/9/1551). The results were published at the end of the four years of activity of the MiLEDI project, which aims at the development of laser technologies and innovative nanomaterials.

"The novelty of these studies lies in having clearly demonstrated how it is possible to change the light emission (colors) of a nanomaterial by acting on the parameters of an easily controllable laser source", explains Leonardo Orazi.



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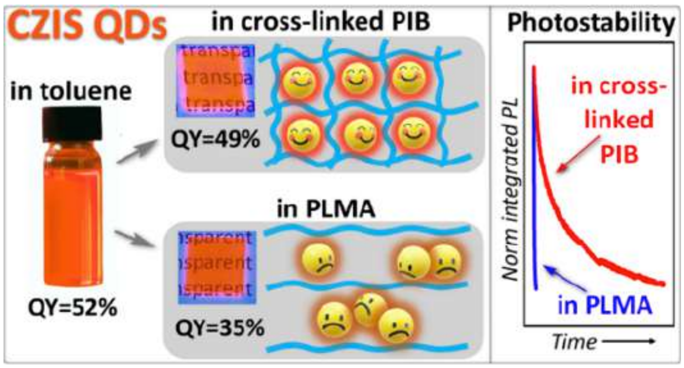
UNIFORM INCORPORATION OF QUANTUM DOT IN A POLYMER

LESNYAK, VLADIMIR

TECHNISCHE UNIVERSITÄT DRESDEN

The Technical University of Dresden (Physical Chemistry group) in close collaboration with colleagues from Belarusian State University (Minsk, Belarus) developed a promising method for uniform incorporation of colloidal Cd-free quantum dots into a flexible cross-linked polyisobutylene matrix which provides excellent encapsulation environment. Photoluminescent quantum dots are a prominent example of nanomaterials used in practical applications, especially in light-emitting and light-converting devices. Vladimir Lesnyak the leader of the research says “Most of the current applications of quantum dots require formation of thin films or their incorporation in solid matrices. A choice of an appropriate host material capable of preventing quantum dots from degradation and the development of a process of uniform incorporation of quantum dots in the matrix have become an essential scientific and technological challenge.”

The results of this work were published in an open access RSC journal Nanoscale Advances: https://pubs.rsc.org/en/Content/ArticleLanding/2021/NA/D0NA01012J#!divAbstract



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University of St Andrews

MiLEDI

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HIGH RESOLUTION OF PHOTO-LITHORAPHIC PATTERNING

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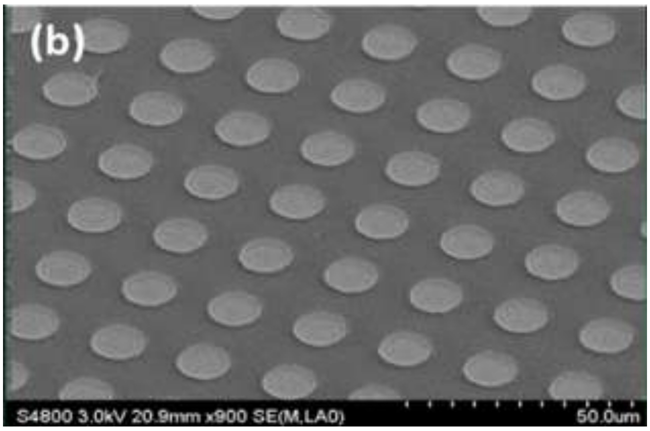
As part of their role in the MiLEDI project, researchers at the University of St Andrews (Organic Semiconductor Centre) developed a novel way of patterning hybrid perovskite films into multi-colour pixels on the micron scale. One of the biggest problems in making micro-displays from semiconductor materials is that it is generally very easy to make a large area emit light in a single colour, but it is much harder to pattern the material into the grid of multi-colour pixels which are needed in a screen.

The leader of the research Prof. I.D.W. Samuel says that "…by incorporating a thin sacrificial layer into the patterning process, researchers at St Andrews were able to give the perovskite films sufficient protection that they could survive the harsh conditions involved in the patterning process unscathed, thus allowing patterns of highly emissive perovskite films to be made with a resolution of about 3 microns – more than sufficient for the next generation of micro-displays".

The results were published in the high impact journal *ACS Nano* - https://doi.org/10.1021/acsnano.8b09592

IFOR SAMUEL

University of St Andrews



MiLEDI

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UNIMORE UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

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MICRO-QUANTUM DOT-OLED DEVELOPPED JOINTLY

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The leader of the research at Fraunhofer of Dresden (FEP) Karsten Fehse says that "…the micro-quantum dot-OLED (QD-OLED) is developed by the University of St. Andrews (USTAN) and Fraunhofer FEP jointly. We worked together towards structuring of Quantumdot-resist by lithography on top of a blue OLED microdisplay. MICROOLED company contributed the quantum dot resist developed by an external company with state-of-the-art properties in view of efficiency and lifetime."

The final QD-micro-display demonstrator was realized by evaporation of a blue OLED onto a 200 mm CMOS-wafer. After deposition of an inorganic thin film encapsulation onto the OLED-Wafer first the green and then the red resist was spin-coated, baked, developed and finally encapsulated with a glass wafer.

A cross section of the final display is shown on the right panel.

KARSTEN FEHSE

Fraunhofer FEP