Deliverable

WP5 – Dissemination and exploitation

D5.6 Project Newsletter (5)

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Table of content

1 Executive summary

1.1. Description of the deliverable content and purpose

Deliverable 5.6 is related to the creation of the fifth PULSE-COM newsletter that will be widely disseminated through different channels (website, social media, mailing list…).

The newsletter is attached to this report and also accessible through this link: https://mailchi.mp/cfe56aeef0a7/6ns78x3rn8-13897760?e=e8145acf5e
Only short sections of each article are provided for that newsletter. The full length is provided on the news section of the official PULSE-COM website (https://www.pulsecom-h2020.eu/news/). Individual links are provided after each article to easily reach them.

In this newsletter, the following points are addressed:

- Presentation of some technical advancements operated by partners;
- Proof of concepts developed by companies;
- Conference in which all of the PULSE-COM results had been presented.

1.2. Brief description of the state of the art and the innovation breakthroughs

N/A

1.3. Corrective action (if relevant)

N/A

1.4. IPR issues (if relevant)

N/A

Deliverable report

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Dear PULSE-COM follower,

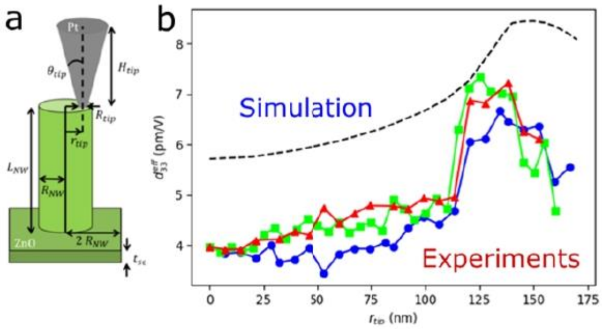
After 43 months of research and development, our project is now reaching its end and soon it will go through its final evaluation by the European Commission. Our project aimed at realizing a radical new class of photo-activated devices changing the current paradigms in the frame of a new area of investigation such as photo-activated piezoelectricity. It will explore and enhance properties of novel, cost-effective photo-mobile polymer (PMP) films combined with modern lead-free piezoelectric (PZL) to produce new composite materials predestined for a wide range of applications never before considered.

We are proud to have worked on this new class of photo-activated devices through four research targets:

- Investigating the relevant materials and design properties
- Identifying radically new solutions and strategies to couple in the appropriate way the two different layers (Photo-Mobile Polymer and Piezo Layer)
- Conceiving, fabricating and demonstrating an innovative light driven actuator (the PMP-PZL device)
- Integrating in opto-electronic systems for advanced industrial implementation: Proof of Concept.

In this final newsletter, you will discover some of our main results, among others: some technical advancements, some proof of concepts developed by companies, and a conference in which all of the PULSE-COM results had been presented.

A new strategy to improve the measurements and analysis at the nanoscale using Piezoresponse Force Microscopy in PULSE-COM project.

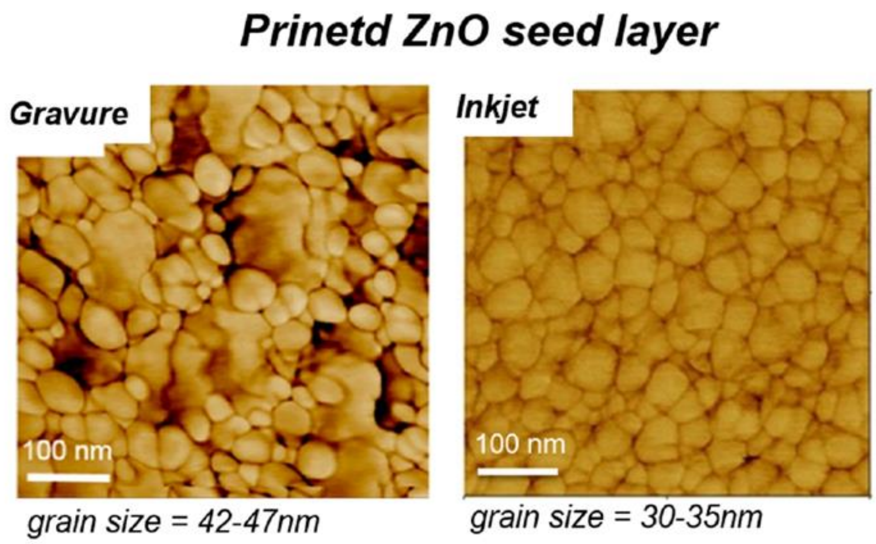


(a) Schematics of the 3D numerical simulation of the deformation of a single NW by PFM, (b) theoretical and experimental values of d_33^eff as a function of the location of the AFM tip at the surface of the NW, (c) experimental PFM amplitude distribution.

Piezoelectric and semiconducting zinc oxide (ZnO) nanowires (NWs) are excellent candidates for the fabrication of energy harvesters, mechanical sensors, piezotronic and piezophototronic devices. Understanding the interplay between piezoelectricity and semiconductor physics is fundamental to enhancing the performance of these devices. Within PULSE-COM we explored the piezoelectric performance of vertically grown ZnO NWs based on Finite Element simulations in the PFM (Piezoresponse Force Microscopy) configuration. In this AFM (Atomic Force Microscope) mode, the AFM tip is placed in contact with the top surface of the NW while applying a voltage, thus inducing a deformation of the structure by the reverse piezoelectric effect. These simulations will help us in the future to obtain guidelines for the optimization of these structures towards applications like electromechanical transducers including sensors and energy harvesters.

For more information, please click [here](#).

Using gravure- and/or inkjet-printing techniques to realize uniform ZnO nanoparticles-based seed layers

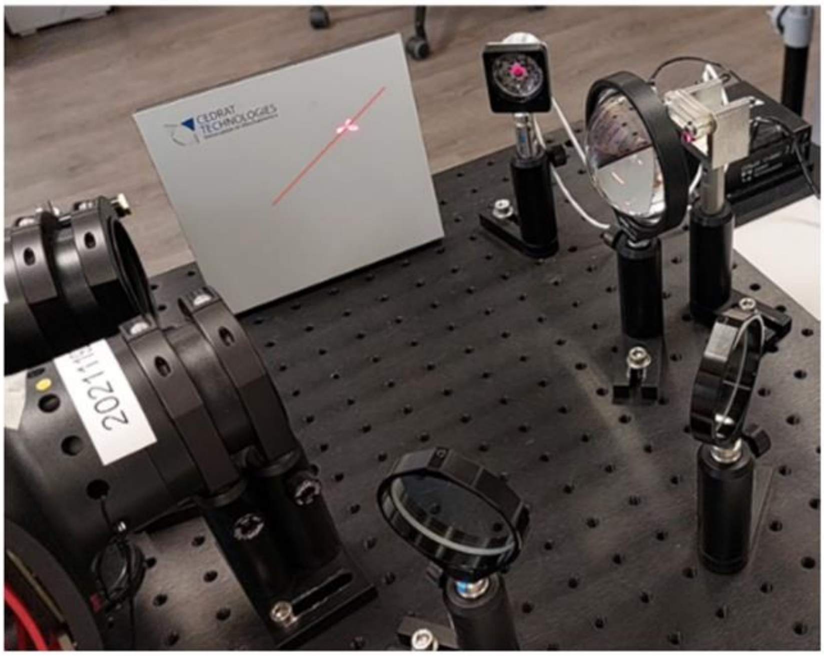


AFM phase images of gravure- and inkjet-printed ZnO seed layers onto ITO/flexible substrate.

Zinc oxide (ZnO) nanowires (NWs) are excellent candidates for the fabrication of energy harvesters, mechanical sensors, piezotronic and piezo-phototronic devices thanks to the interplay between piezoelectric and semiconducting properties. The growth of ZnO NWs on flexible substrates would further broaden their possible applications. However, such a growth requires low temperature synthesis to prevent any damage to the flexible polymer. Another difficulty lies in the fact that the deposition of patterned ceramic thin films on flexible substrates is challenging, especially under vacuum free conditions. In this framework, printing technologies like inkjet and gravure printing have a noteworthy potential since they allow to deposit thin films onto flexible substrates and offer several other advantages like cost efficiency, use of low temperatures, high throughput and the capability of patterning during the deposition process.
In our study we demonstrated the possibility to realize uniform ZnO nanoparticles-based seed layers on polyethylene terephthalate (PET) substrate by gravure- and/or inkjet-printing techniques and then grow high quality ZnO NWs by applying a chemical bath deposition (CBD) process.

For more information, please click here.

New range of light driven devices

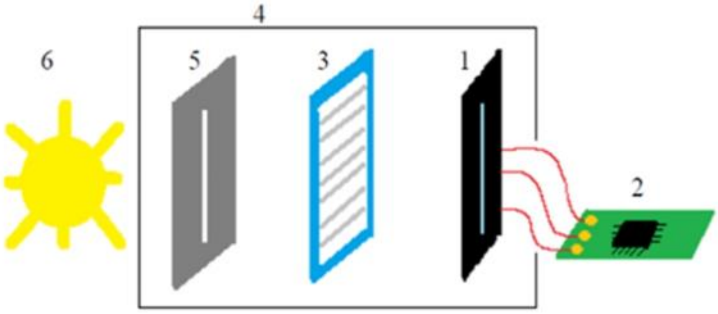


Optical deflectors based on a photomobile films.

The recent progresses made in the manufacturing of new plasmonic photomobile films are offering an innovative solution for light induced motion actuators and devices. Indeed, such films can be assimilated as transducers thanks to their ability to convert light into displacement with strokes up to several millimetres. By adjusting the incident light parameters the photomobile films actuation can be controlled to answer many applications requesting high displacements and low forces. Several proof-of-concepts of these devices were manufactured such as light driven optical switch, optical micro-valve and deflector.

For more information, please click here.

Practical implementation of optical spectrometer



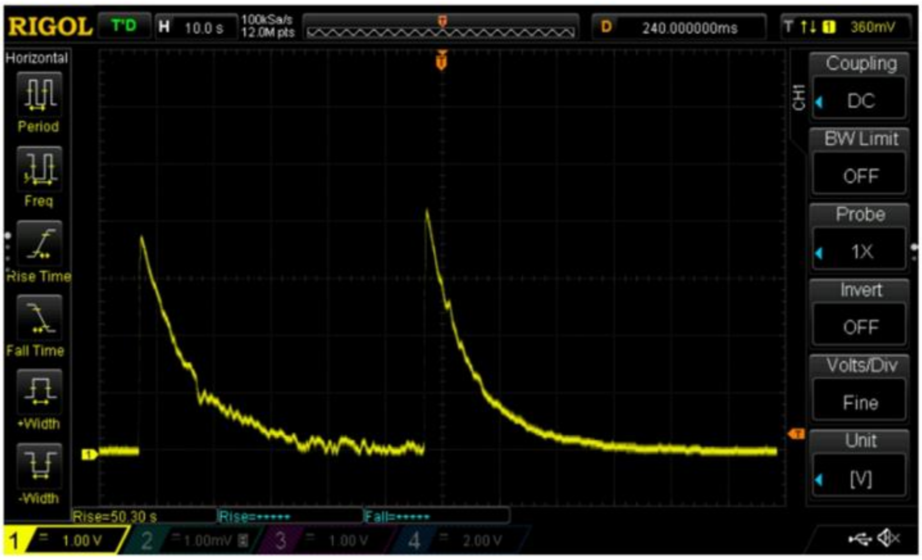
Bloc diagram of the spectrometer.

A concept of hardware bloc of a designed spectrometer had been developed in the scope of the PULSE-COM project.

The light that passes through the pinhole is decomposed on the diffraction grating. The image of the diffraction pattern is captured by the CMOS camera. The setup resolution for these captures is 640 x 320 pixels. The captured image is analysed by the image processing algorithms, implemented in the custom-developed software. The output of this analysis will plot the spectrum of the light source. The calibration process of the spectrometer is done with an RGB LED, which defines an active area of 400 pixels from the 640 pixels available on the captured images. In this manner, the 400 pixels will correspond to the 380-750 nm visible spectrum, which ensure a resolution for the spectrometer close to 1 nm/pixel.

For more information, please click here.

Photo-mobile polymers in energy harvesting applications under simulated solar light

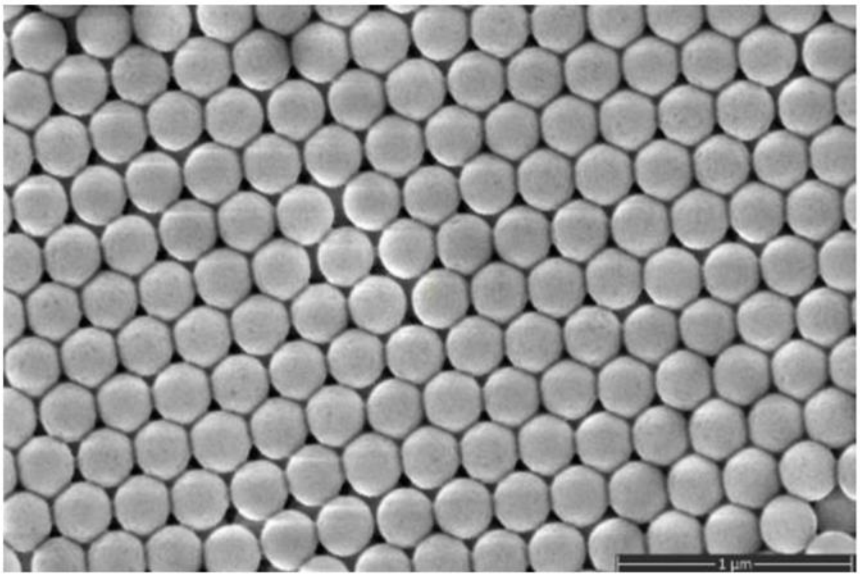


Steady state operation of PMP-PZM system. Measured on 64 MOhm load via buffer amplifier and ideal rectifier

Azobenzene-based photo-mobile polymer (PMP) samples were mechanically coupled with foils of commercial piezoelectric material (PZM) (Sensor DT Series Piezo Film vibration, by TE Connectivity). The obtained assembly was placed under a solar simulator to mimic the absorption spectrum of earth's atmosphere. The system was capable of operating in direct sunlight and generated measurable energy on the load. Peak voltage of over 4 V was achieved and discharged an average of 710 nJ over a 50 s period. This result could be significantly improved but was limited by the mechanical capabilities of the shutter.

For more information, please click here.

Optical properties of opal structures on PMP covered with plasmonic ultra-thin Ag films



SEM image of the opal structure on doped PMP

For the final demonstration of new optical functionalities added to PMP doped with 6% ZnO a silver ultra-thin plasmonic film of 7 nm thickness was deposited on one face of the PMP and an original set-up was designed. It has been possible to show a reflected light before and during optical motion induced by a structured opal on ultrathin silver plasmonic film on azobenzene doped with 6% ZnO.

For more information, please click here.

PULSE-COM final workshop happened in partnership with a SPIE conference

Most of the PULSE-COM team in the SPIE Optics + Optoelectronics conference in April 2023

From 25th to 27th of April, the whole PULSE-COM consortium was in Prague (Czech Republic) to conduct its final workshop, presenting the main results obtained on this FET-OPEN project. Inside the SPIE Optics + Optoelectronics 2023 conference (https://spie.org/conferences-and-exhibitions/optics-and-optoelectronics), a dedicated sessions called “Smart Materials for Opto-Electronic Applications” had been organised in which the workshop had taken place. Overall, it had been the occasion to hear research advancements and findings from 4 plenary presentations, 4 keynote presentations, 19 invited papers, 7 regular presentations and 10 posters. All these presentations had been chaired by Ivo Rendina (CNR), Lucia Petti (CNR), Domenico Sagnelli (CNR) and Giuseppe Nenna (ENEA).

For more information, please clik here.

https://www.pulsecom-h2020.eu/

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