



Deliverable 7.5

Dissemination Plan – Part 2

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Author(s):	J. Volk, G. Battistig
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RESTRICTED DISSEMINATION to consortium

EXECUTIVE SUMMARY

This document summarizes the dissemination activities of the consortium during the 44-month duration of the project. It includes presentations at domestic and international conferences and workshops, the published papers, PhD dissertations, the PiezoMat open workshop, the press releases as well as the website of the project. Besides, it also lists some dissemination activities planned beyond the end of the project.



REVISION HISTORY

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V1			

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1 Introduction

In accordance with the plan published in the third month of the project (D7.1), dissemination activities of the consortium included i) participation to conferences and workshops in various domains relevant to the project topics, ii) publishing scientific papers, iii) organization of an open workshop, iv) website maintenance, and v) press releases. The aim of the PiezoMAT project is to design a new technology of high-resolution fingerprint sensor based on a matrix of inter-connected piezoelectric nanowires (NWs). As a result, PiezoMAT is a strongly interdisciplinary project tackling both fundamental and R&D research matters and covering the fields of:

- Materials science (nanowire growth, patterning, structural characterisation)
- Multi-scale mechanical, electrical and piezoelectric characterisations of nanomaterials and devices
- Multi-scale and multi-physics modelling (FEM simulations and ab initio calculations),
- Microfabrication (clean-room processing of large MEMS arrays)
- Packaging (polymer encapsulation)
- Biometrics (fingerprint sensors)

As it will be shown in this document dissemination activities covered all the above listed fields.

2 Conferences

PiezoMAT consortium was very active in the dissemination of the scientific results on various domestic, EU, and overseas conferences, workshops, and seminars. The altogether 32 oral and poster presentations cover all the above listed fields (Table 1). Among the international conferences it is worth highlighting the Eurosensors series which is the largest sensor conference in the EU and the NPGT (International Conference on Nanogenerators and Piezotronics) conference which relates very strongly to our project. Consortium partners have delivered 8 and 5 presentations to these conferences, respectively. Besides, the partners have also attended several events which are more focused to a certain field, such as computer simulation (EuroSim-E, International Conference on Thermal, Mechanical and Multi-Physics Simulation and Experiments in Microelectronics and Microsystems).

Date	Presenter	Title	Event
Oct. 2017	E. Pauliac-Vaujour	Challenges of Nanosystem Architectures: Realistic Paths to Multi-Scale, Multi-Modality Integration	Nano S&T 2017, Fukuoka, Japan (accepted, oral)
Sept. 2017	E. Saoutieff	Axially stressed piezoelectric nanowires for high resolution tactile imaging	Eurosensors 2017, Paris, France (accepted, oral)
July 2017	A. Graillet	Design of UV-Crosslinked Polymeric Thin Layers for Encapsulation of Piezoelectric ZnO Nanowires for Pressure-Based Fingerprint Sensors	European Polymer Congress, Lyon, France (accepted, oral)
March 2017	A. Shkurmanov	Al-doped ZnO nanowires grown by PLD	Annual Conf. of the DPG and DPG Spring Meeting
Dec. 2016	E. Saoutieff	Individually contacted piezoelectric nanowires integrated onto a microelectronics chip	PiezoNEMS workshop, Grenoble, France
Sept. 2016	J. Volk	Integrated Piezoelectric Nanowire Arrays for High Resolution Tactile Mapping	Eurosensors 2016, Budapest, Hungary (oral)
Sept. 2016	E. Saoutieff	Integration of piezoelectric nanowires matrix onto a microelectronics chip	Eurosensors 2016, Budapest, Hungary (oral)
Sept. 2016	B. Christian	Piezo-force and vibration analysis of ZnO nanowire arrays for sensor application	Eurosensors 2016, Budapest, Hungary (poster)
Sept. 2016	A. Bouvet-Marchand	UV-crosslinked polymeric materials for encapsulation of ZnO nanowires in piezoelectric fingerprint sensors	Eurosensors 2016, Budapest, Hungary (poster)
Sept. 2016	A. Shkurmanov	Growth kinetics of ultrathin ZnO Nanowires grown by Pulsed Laser Deposition	Eurosensors 2016, Budapest, Hungary (poster)

Sept. 2016	R. Dauksevicius	Finite element analysis of polymer-encapsulated ZnO nanowire-based sensor array intended for pressure sensing in biometric applications	Eurosensors 2016, Budapest, Hungary (poster)
Sept. 2016	A. Shkurmanov	Tilted nanowires as building block for hyperbolic metamaterials	Scientific Module 2016-T6, Leipzig, Germany (poster)
June 2016	E. Saoutieff	Interconnected array of piezoelectric nanowires integrated onto a microelectronics chip: the PIEZOMAT project	Intl. Conference on Nanogenerators and Piezotronics 2016, Rome, Italy (oral)
June 2016	J. Volk	Bottom contacted piezoelectric nanowire arrays for high resolution tactile mapping	Intl. Conference on Nanogenerators and Piezotronics 2016, Rome, Italy (oral)
June 2016	E. A. A. Leon Perez	On-chip integration of individually contacted piezoelectric nanowires for fingerprint sensing applications	Intl. Conference on Nanogenerators and Piezotronics 2016, Rome, Italy (oral)
June 2016	A. Shkurmanov	Controlling of the geometrical shape of ZnO nanowires by pulsed laser deposition	Intl. Conference on Nanogenerators and Piezotronics 2016, Rome, Italy (poster)
May 2016	A. Shkurmanov	Growth of ultrathin ZnO nanowires at CMOS compatible temperature by pulsed laser deposition	E-MRS Spring Meeting 2016, Lille, France
Apr. 2016	R. Dauksevicius	Numerical study of near-optimal parameters of polymeric encapsulation layer containing a periodic array of piezoelectric nanowires used for force sensing	EuroSimE 2016, Montpellier, France
March 2016	A. Shkurmanov	Growth of tilted ZnO nanowires by PLD on pre-structured sapphire substrates	Annual Conf. of the DPG and DPG Spring Meeting
March 2016	A. Shkurmanov	CMOS-compatible PLD-growth of ultrathin ZnO nanowires	Annual Conf. of the DPG and DPG Spring Meeting
Sept. 2015	R. Dauksevicius	Multiphysics model of encapsulated piezoelectric-semiconducting nanowire with Schottky contacts and external capacitive circuit	Eurosensors 2015, Freiburg, Germany
Sept. 2015	A. Shkurmanov	Growth of ultrathin ZnO nanowires	Minisymposium – Quantum Coherent Structures, Leipzig, Germany (poster)
July 2015	M. Seifika	Enhanced pressure response in ZnO nanorods due to spontaneous polarization charge	15 th IEEE-Nano, Rome, Italy (oral)
July 2015	E. A. A. Leon Perez	Pixel analysis of a force-sensing device based on individually contacted vertical piezoelectric nanowires	15 th IEEE-Nano, Rome, Italy
July 2015	E. A. A. Leon Perez	Bending piezoelectric nanowires: application to force-displacement sensors based on individually contacted vertical ZnO piezoelectric nanowires	Mechanical issues for advanced electron devices, Grenoble, France (poster)
June 2015	E. A. A. Leon Perez	Some design and integration considerations for piezoelectric sensors based on individually contacted vertical ZnO nanowires	SETCOR NANOTECH 2015, Paris, France (poster)
Apr. 2015	R. Dauksevicius	Finite Element Modeling of ZnO Nanowire with Different Configurations of Electrodes Connected to External Capacitive Circuit for Pressure Sensing Applications	EuroSimE 2015, Budapest, Hungary
March 2015	A. Shkurmanov	Low temperature PLD-growth of ZnO nanowires on Zn _x Al _{1-x} O films	Annual Conf. of the DPG and DPG Spring Meeting
Sept. 2014	A. Shkurmanov	Low temperature PLD-growth of ZnO nanowires	TCO2014, Leipzig, Germany (oral)
June 2014	E. A. A. Leon Perez	Unit-cell design of a force sensing device based on vertical piezoelectric nanowires	Intl. Conference on Nanogenerators and Piezotronics 2014 (oral)
May 2014	J. Volk	Integration of vertically aligned ZnO nanorods into novel optoelectronic and sensor devices	10 th Intern. Nanotechnology Conference on Communication and Cooperation, Gaithersburg, USA (poster)
March 2014	A. Graillet	R&D – Production – 1 g/1 kg Monomers & Polymers Fonctionnels	PolyRay, Montpellier, France

Table 1 List of conference presentations of PiezoMat partners

3 Journal papers

Beyond conference and workshop presentations the most important scientific findings of the consortium have been published in 5 peer reviewed journal papers and in 9 conference issues of scientific journals (Procedia Engineering and IEEE). Among these papers, research findings obtained on A-I structures have been published in the prestigious journal of the American Chemical Society (ACS Appl. Mater. & Interfaces) having an impact factor of 7.145.

Authors	Title	Journal
A. Shkurmanov, C. Sturm, H. Franke, J. Lenzner, M. Grundmann	Low-Temperature PLD-Growth of Ultrathin ZnO Nanowires by Using Zn(x)Al(1 - x)O and Zn(x)Ga(1 - x)O Seed Layers	Nanoscale Research Letters 12 (2017) 134
A. Shkurmanov, C. Sturm, J. Lenzner, G. Feuillet, F. Tendille, P. De Mierry, M. Grundmann	Selective growth of tilted ZnO nanoneedles and nanowires by PLD on patterned sapphire substrates	AIP ADVANCES 6 095013-1 (2016)
N. Petkov J. Volk R. Erdélyi, I. E. Lukács, T. Nagata, C. Sturm, M. Grundmann	Contacting ZnO Individual Crystal Facets by Direct Write Lithography	ACS Appl. Mater. Interfaces 8 23891 (2016)
Edgar A. A. Leon Perez Emmanuelle Pauliac-Vaujour and Mireille Mouis	Static Finite Element Modeling for Sensor Design and Processing of an Individually Contacted Laterally Bent Piezoelectric Nanowire	IEEE Transactions on Nanotechnology 15 (3) 2016
Z. Zolnai M. Toporkov J. Volk D.O. Demchenko, S. Okur Z. Szabó Ü. Özgür H. Morkoc V. Avrutin E. Kótai	Nondestructive atomic compositional analysis of BeMgZnO quaternary alloys using ion beam analytical techniques	Applied Surface Science 327 (2015) 43–50
B. Christian J. Volk I. E. Lukács E. Saoutieff C. Sturm A. Gailliot R. Dauksevicius M. Seifikar O. Ambacher V. Lebedev	Piezo-force and vibration analysis of ZnO nanowire arrays for sensor application	Procedia Engineering 168 1192 (2016)
A. Bouvet-Marchand M. Loubat A. Gailliot J. Volk R. Dauksevicius E. Saoutieff A. Viana B. Christian V. Lebedev C. Sturm C. Loubat	UV-crosslinked polymeric materials for encapsulation of ZnO nanowires in piezoelectric fingerprint sensors	Procedia Engineering 168 1135 (2016)
A. Shkurmanov C. Sturm, H. Hochmuth, M. Grundmann	Growth kinetics of ultrathin ZnO Nanowires grown by Pulsed Laser Deposition	Procedia Engineering 168 1156 (2016)
Rolanas Dauksevicius Rimvydas Gaidys Eoin P. O'Reilly Masoud Seifikar	Finite element analysis of polymer-encapsulated ZnO nanowire-based sensor array intended for pressure sensing in biometric applications	Procedia Engineering 168 864 (2016)
E. Saoutieff M. Allain Y-R. Nowicki-Bringuier A. Viana E. Pauliac-Vaujour	Integration of piezoelectric nanowires matrix onto a microelectronics chip	Procedia Engineering 168 1638 (2016)
R. Dauksevicius R. Gaidys, E. P. O'Reilly, M. Seifikar	Multiphysics model of encapsulated piezoelectric-semiconducting nanowire with Schottky contacts and external capacitive circuit	Procedia Engineering 120 896 (2015)
R. Dauksevicius, R. Gaidys, E.P. O'Reilly, M. Seifikar	Numerical study of near-optimal parameters of polymeric encapsulation layer containing a periodic array of piezoelectric nanowires used for force sensing	IEEE EuroSim-E 2016 (doi: 10.1109/EuroSimE.2016.7463342)
R. Dauksevicius, R. Gaidys, E. O'Reilly, M. Seifikar	Finite element modeling of ZnO nanowire with different configurations of electrodes connected to external capacitive circuit for pressure sensing applications	IEEE EuroSim-E 2015 (doi: 10.1109/EuroSimE.2015.7103134)
M. Seifikar, E.P. O'Reilly, B.P. Christian, V. Lebedev, J. Volk, R. Erdelyi, I.E. Lukács, R. Dauksevicius, R. Gaidys	Enhanced pressure response in ZnO nanorods due to spontaneous polarization charge	IEEE Nano, (doi: 10.1016/j.proeng.2016.11.374)

Table 2 List of papers published in peer reviewed scientific journals and conference proceedings

In addition two further manuscripts have already submitted to prestigious scientific journals (ACS Appl. Mater. & Int. and Nano Energy) and two papers are under preparation (Table 3). They are planned to be submitted shortly after closing the project.

Authors	Title	Journal
A. Bouvet-Marchand, A. Graillet, J. Volk, R. Dauksevicius, C. Sturm, E. Saoutieff, A. Viana, B. Christian, V. Lebedev, J. Radó, I. E. Lukács, M. Grundmann, D. Grosso, C. Loubat	Design of UV-Crosslinked Polymeric Thin Layers for Encapsulation of Piezoelectric ZnO Nanowires for Pressure-Based Fingerprint Sensors	2017, submitted to ACS Appl. Mater. & Interfaces
M. Seifkar, B. P. Christian, J. Volk, R. Erdélyi, I. E. Lukács, R. Dauksevicius, R. Gaidys, V. Lebedev, E. P. O'Reilly	Direct observation of spontaneous polarization charge transfer in stressed ZnO nanorods	2017, submitted to Nano Energy
J. Radó, J. Volk et al.	Integrated piezoelectric nanowire arrays for high resolution tactile mapping	Under preparation, to be submitted in 2017
C. Sturm, A. Shkurmanov et al.	Growth kinetics of the Zn(x)Al(1-x)O and Zn(x)Ga(1-x)O nanowires by PLD	Under preparation, to be submitted in 2017

Table 3: List of manuscripts submitted to scientific journals or under preparation

Beyond journal papers, the scientific results have been published in one defended PhD thesis and another one will be disseminated still this year as summarized in Table 4.

Author	Title	University, year
R. Erdélyi	Synthesis and mechanical characterization of wet chemically grown ZnO nanowires for nanoelectromechanical sensors	PE, Veszprém, Hungary, 2014
A. Shkurmanov	Growth kinetics and shape variation of ZnO based nanostructures	ULEI Leipzig, Germany, 2017 (under preparation)

Table 4: PhD dissertations defended and under preparation

4 Press release

Press releases have been presented by the project coordinator (CEA) and by the technical manager (Fraunhofer-IAF) in English, by Specific Polymers in French, and by ULEI in German:

- CEA: http://www.piezomat.eu/files/docs/Press/PIEZOMAT_2014-02-14_press_release_CEA.pdf
- <https://www.iaf.fraunhofer.de/en/offers/semiconductor-sensors/piezomat.html>
- Specific Polymers (http://www.piezomat.eu/files/docs/Press/PIEZOMAT_2014-02-07_press_release_SP.pdf)
- ULEI: <http://www.leipzig.de/en/news/news/neuer-fingerabdrucksensor-soll-sicherheit-in-biometrie-verbessern-projekt-piezomat-gestartet/>

These announcements were also advertised on a few web Portals such as

- Solid State Technology, 24 Feb. 2014 (<http://electroiq.com/blog/2014/02/cea-leti-announces-the-launch-of-piezomat/>)
- Business Wire, 11 Feb., 2014 (<http://www.businesswire.com/news/home/20140211006635/en/Leti-Partners-PIEZOMAT-Project-Target-Fingerprint-Technology>)

- FindBiometrics, 11 Feb. 2014 (<http://findbiometrics.com/cea-leti-launches-piezomat-aims-to-design-ultra-high-res-fingerprint-sensor-02111401/>)
- Biometric Technology Today (http://www.piezomat.eu/files/docs/Press/PIEZOMAT_2014-02-14_press_release_CEA.pdf)

Besides, a final press release will also be presented until the end of the project (D7.7).

5 Open workshop (D7.4)

The workshop was organized by MTA EK MFA as a satellite event of the XXXth EuroSensors conference (<http://www.piezomat.eu/workshop>). The main motivation of this joint event was to attract a broad audience from the sensor community (Fig. 1). The workshop was held on the last day of the conference (Sep. 7, 2016) just before closing remarks and for an audience of about 80 people from all around the world.



Figure 1: Consortium partners around the roll-up poster of the workshop in Budapest (a-b), lecture given by Stéphane Revelin from SafranGroup (c), and part of the audience (d).

The main motivation, the obtained results, and the research potential were summarized in seven lectures delivered by the project partners (Table 6).

Partner	Affiliation	Title
A. Viana	CEA LETI	Introduction of the PiezoMAT EU FP7 project
M. Allain	CEA LETI	Heterogeneous integration of nano-objects onto microelectronics chips in CEA clean rooms
S. Revelin	Safran Identity & Security	High resolution fingerprint sensing – next generation in biometric identification
C. Sturm/ J. Volk	ULEI/MTA EK MFA	On chip integration of piezoelectric nanowires

A. Graillet	Specific Polymers	On demand Functional polymers and materials for optoelectronic devices and sensors
V. Lebedev	Fraunhofer IAF	Piezo-electro-mechanical characterization of nano-wire sensor structures
N. Petkov	Tyndall	Nanowire devices for beyond CMOS technologies: lithography contacting challenges

Table 6: List of presenters and title of the talks on the PiezoMat open workshop

6 PiezoMat website

The PiezoMat website contains a public section, accessible by everyone on the Internet, and “partners” and “officials” sections accessible only to selected users – consortium members and EC officials respectively – and protected by usernames and passwords. The public section aims to present i) the description of the project concept and objectives, ii) the consortium members, including logos and main contact details, iii) events and news related to the project, iv) the published papers and conference participations, as well as v) the press release materials.

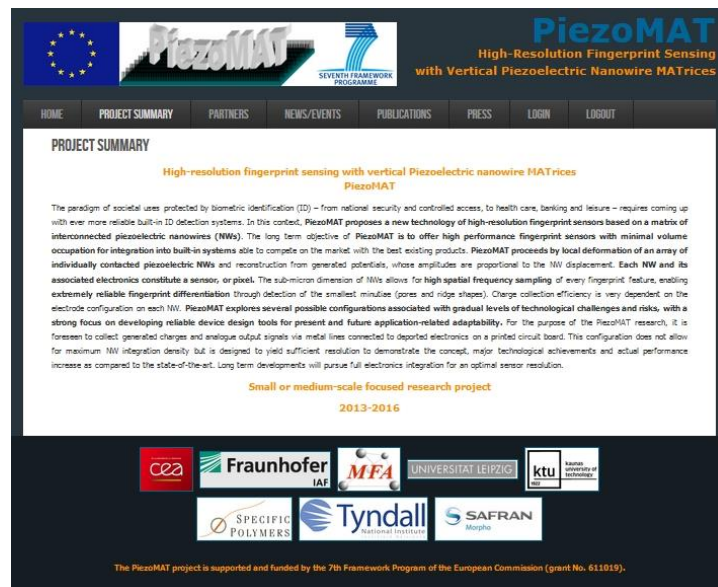


Figure 2: Screenshot taken on the public section of PiezoMat website (www.piezomat.eu)

The internal page, dedicated to ‘partners’ and ‘officials’, supports the whole consortium in everyday work and information exchange as well as the reviewers to follow the progress of the project. It contains the following sections: project documentations, workpackages, tasks, planning, templates, events, deliverables, quarterly and annual reports, sample exchange, technical results, comments and recent comments. The website of the project (www.piezomat.eu) has been continuously updated and in 2016 it went through a graphical transformation to catch the eyes of the visitors by highlighted pictures. In addition, on the request of the reviewers the partners have collected the present state-the-art of each addressed fields and shown in a separate section of the internal page. For the same reasons the manuscripts which are in the pipeline to publication or submissions are also indicated in a subsection (internal page: Dissemination Activities/Manuscript to be published). The internal page also reflects the high intensity of research collaboration of the partners. As shown under the Sample Exchange, the partners have transferred samples in 113 cases during the project. Each of them has been documented in the downloadable reports.

7 Summary

In summary, the consortium was very active in different forms of dissemination activities. A high number of presentations (32) have been given at several scientific conferences which cover all domains of the interdisciplinary project. Besides, as planned at the beginning of the project (D7.2)), a PiezoMat open workshop was held in Sep. 2016 to attract the interest of potential academic and industrial partners. More relevant results, especially the ones which are basic research related, have also been published in peer reviewed scientific papers (5). In addition, at least four further papers have already been submitted or planned to be submitted soon to relevant scientific journals of the fields. No patent applications have been made by the partners. All relevant information for public, for the consortium members, and for the project officers are available at the continuously updated website of the project (www.piezomat.eu)