DELIVERABLE REPORT D3.9

DELIVERABLE

SUBMISSION DATE	NAME OF THE DELIVERABLE	WORK PACKAGE
28.6.2021	Scientific Communication	WP3
NATURE	AUTHOR(S)	LEAD BENEFICIARY
Public	Božena Čechalová	BUT

PROJECT DETAILS

PROJECT ACRONYM	PETER	GRANT AGREEMENT	767227
CALL IDENTIFIER	H2020-FETOPEN-1-2016-2017	PROJECT DURATION	1.1.2018 – 30.6.2021
PROJECT OFFICER	Remus Iacobescu	PROJECT COORDINATOR	Tomáš Šikola (BUT)
CONSORTIUM PARTNERS	Brno University of Technology	COUNTRY	Czech Republic
	Universität Stuttgart		Germany
	CIC nanoGUNE		Spain
	Thomas Keating Ltd.		United Kingdom

QUALITY CONTROL ASSESSMENT SHEET

VERSION	DATE	DESCRIPTION	NAME
v0.1	3. 6. 2021	First draft	Božena Čechalová (BUT)
v0.2	10. 6. 2021	Review first draft, contribution to section 2	Tomáš Šikola (BUT)
v0.3	11. 6. 2021	Review first draft, contribution to section 1	Joris van Slageren (USTUTT)
v0.4	14. 6. 2021	Review first draft, language check	Alisa Leavesley (TK)
v0.5	21. 6. 2021	Contribution to Annex 1	Monika Goikoetxea (NGU)
v1.0	28. 6. 2021	Final draft and submission	Božena Čechalová

DISCLAIMER

ACKNOWLEDGEMENT

This document is a deliverable of the PETER project, which has received funding from the European Union's Horizon 2020 Programme under Grant Agreement (GA) #767227.

TABLE OF CONTENTS

SUMMARY

The D3.9 deliverable report of the PETER project “Scientific Communication” (submitted in M42) summarizes the channels through which the results of the projects have been communicated to the scientific community: through peer-reviewed journal publications, conference presentations and posters, and presentations at PETER-organised international workshops.

INTRODUCTION

The report on scientific communication presented in this document includes a comprehensive information on the PETER project's actions to communicate the results of the project to the scientific community. It includes:

- Publications in peer-reviewed journals,
- Other scientific publications,
- Conference presentations.

Separately, we also included an overview of PETER-related presentations on workshops organised by the PETER project.

During the proposal-writing phase, we expected to achieve at least 10 peer-reviewed publications in high-impacted journals, as well as at least 8 conference presentations, during the project lifetime. In reality, we only published 5 papers between January 2018 and June 2021, although the conference presentations goal was fulfilled above expectations.

FET-OPEN projects are, by their nature, high-risk research projects. Some of these risks materialised during the implementation of the project, along with risks that we could not have predicted (most of all, the Covid-19 pandemic, and the UK leaving the European Union without a customs and trade agreement). As a result, we have not yet achieved the main project goal, the PE THz EPR microscopy, even though it is likely that we will achieve it within two years after the project end. Publications detailing this main project results are, at the time of submission of this report, still in the process of being written or are under peer review.

As the scientific work on the project will continue even after June 2021 (we are envisioning approx. two years of test experiments to obtain the proof-of-concept PETER microscopy and to get the microscopy feature to its maximum performance), we expect the further publications on the topic of PETER. According to the H2020 principles and guidelines outlined in our Data Management Plan (D3.4) and Open Research Data Pilot (D3.10), we will continue to enable open access to publications and research data and maintain the current publication and dataset repositories.

1. SCIENTIFIC PUBLICATIONS – IN PEER-REVIEWED JOURNALS

PETER project complies with the H2020 programme requirements for open access to scientific publications. The publications (papers in peer-reviewed journals) are made either Gold Open Access (accessible to anyone free of charge directly on the publisher's website) or Green Open Access (self-archiving of the accepted manuscript including all reviews and editorial input).

For self-archiving the publications in Green Open Access, we have selected the ZENODO repository (for further details, see the report D3.10). A central repository (allowing search by title, publication date, DOI, journal citation, authors, and keywords in abstract) on project publications is created on the PETER project website https://www.peter-instruments.eu/inpage/publications/.

A summary table of project-related publications is given in Table 1.

Table 1: Summary of the project publications (also available through Funding & Tenders Portal)

DOI	Authors	Title	Journal citation	Open Access/Link to full text
10.1021/acsphotonics.8b00636	Stefan Mastel, Alexander A. Govyadinov, Curdin Maissen, Andrey Chuvilin, Andreas Berger, and Rainer Hillenbrand	Understanding the Image Contrast of Material Boundaries in IR Nanoscopy Reaching 5 nm Spatial Resolution	*ACS Photonics,* 2018, 5 (8), pp 3372-3378	Green; https://zenodo.org/record/4736982
10.1021/acsphotonics.9b00324	Curdin Maissen, Shu Chen, Elizaveta Nikulina, Alexander Govyadinov and Rainer Hillenbrand	Probes for Ultrasensitive THz Nanoscopy	*ACS Photonics* 2019, 6, (5), pp 1279-1288	Green; https://zenodo.org/record/4737029
10.1103/PhysRevApplied.13.054045	Martin Hrtoň, Andrea Konečná, Michal Horák, Tomáš Šikola, and Vlastimil Křápek	Plasmonic Antennas with Electric, Magnetic, and Electromagnetic Hot Spots Based on Babinet's Principle	Phys. Rev. Applied, 2020, **13**, 054045	Gold
10.1002/adfm.202006882	Michal Kern, Lorenzo Tesi, David Neusser, Nadine Rußegger, Mario Winkler, Alexander Allgaier, Yannic M. Gross, Stefan Bechler, Hannes S. Funk, Li-Te Chang, Jörg Schulze, Sabine Ludwigs, and Joris van Slageren	Hybrid Spintronic Materials from Conducting Molecular Quantum Bits	Adv. Funct. Mater. 2020, 20006882	Gold
10.1021/acsphotonics.0c01541	Chao Chen, Shu Chen, Ricardo P.S.M. Lobo, Carlos Maciel-Escudero, Martin Lewin, Thomas Taubner, Wei Xiong, Ming Xu, Xinliang Zhang, Xiangshui Miao, Peining Li, and Rainer Hillenbrand	Terahertz Nanoimaging and Nanospectroscopy of Chalcogenide Phase-Change Materials	*ACS Photonics* 2020, **7**, (12), pp 3499–3506	Gold

2. OTHER SCIENTIFIC PUBLICATIONS - THESES ON PETER RELATED TOPICS

Semianalytical approach to simulations in nanophotonics

Martin Hrtoň (supervisor: Tomáš Šikola), BUT 2021 (to be defended in July)

Data post-processing lies at the focus of this thesis, with emphasis on the development of semianalytical models that are tailored specifically to each type of experiment, providing better insight into its physical background and improved agreement between theory and measurements. A major part of the thesis is dedicated to the plasmon enhanced electron paramagnetic resonance (PE EPR), a novel technique employing metallic antennas for enhancing the interaction between light and materials exhibiting magnetic spin transitions. Fundamental principles of this effect are laid down and a model facilitating rapid optimization of antenna arrays for thin film PE EPR spectroscopy is presented. Particular attention is paid to the current distribution and to advantages it offers when dealing with far-field projections and electromagnetic interaction between objects. This is further demonstrated on several applications, namely the phase imaging of metasurfaces using coherence controlled holographic microscope, the design of a metasurface-based fan-out element, and the multipolar analysis of far-fields generated by objects embedded within stratified media.

Deposition of Large Organic Molecules in UHV Conditions

Tomáš Krajňák (supervisor: Jan Čechal), BUT 2019

In this thesis, large organic molecules ($DM_{15}N$, $DM_{18}N$, $Cu(dbm)_2$) were deposited. These molecules cannot be deposited by thermal sublimation due the fact that they decompose at lower temperature than they sublime. The employed molecules to single molecular magnets, which can be potentially used as quantum bites (qubit). The new method of deposition by atomic layer injection made by Bihur Crystal company was introduced and tested. The method uses a liquid solution with molecules which is driven by argon gas through a pulse valve to the sample placed in an ultra-high vacuum chamber. During the deposition, droplets of solution are formed on the sample surface. The solvent can be removed by light annealing or by keeping the sample in the vacuum for couple of days. The molecules were investigated by x-ray photoelectron spectroscopy and by scanning electron microscopy to determine fragmentation of the molecules, to study topography of the resultant surface and homogeneity of the deposited layer. We found conditions at which the intact molecules are deposited on sample surfaces and form molecular nano- and micro- crystals.

Terahertz time domain spectroscopy of diabolo antennas

Katarína Rovenská (supervisor: Rainer Hillenbrand), CIC NanoGUNE 2019

The presented thesis deals with the initial steps of the PETER project and describes the main outcomes of the work done within the months of six-month stay at CIC nanoGUNE. This was mainly focused on the plasmonic part of the project, specifically on the fabrication of micro-scale plasmonic diabolo antennas via direct laser writing and the characterization of these antennas by the means of terahertz time domain spectroscopy (THz-TDS).

3. CONFERENCE PRESENTATIONS

A comprehensive summary of conference presentations (orals and posters) where PETER results have been disseminated to the scientific community is given **in Annex 1.**

Note that the Annex 1 lists only conferences and workshops where PETER project was not the organizer. Presentations from the PETER Summer School in Brno, CZ (M10), 1st International Workshop for Scientific Community in Hirschegg, AT (M18), and 2nd International Workshop for Scientific Community – online at CIC NanoGUNE (M39) are listed **in Annex 2**.

4. METADATA REPOSITORY

A metadata repository for publications (and their corresponding ORDP datasets, for reference see deliverable D3.10) has been created on the PETER project website https://www.peter-instruments.eu/inpage/metadata/ and allows to search within the data according to file description, dataset type, authors, related journal of publication, data format, and keywords.

A similar metadata repository on events outputs (presentations, recordings) has been created to allow an easy search within the outputs of PETER workshops (mainly PETER Summer School and two International workshops for scientific community): https://www.peter-instruments.eu/inpage/metadata-events-output/. This metadata repository allows search according to type of output, author, related event, format of datafile, and topic keywords.

ANNEX 1 – LIST OF PRESENTATIONS ON CONFERENCES

Overview of PETER dissemination on conferences - M1-M12						
Date	**Activity**	**Audience**	**Outreach**	**Event (link)**	**Presenter**	**Title**
6 – 9. 5. 2018	poster	academic	100	6th EOS Topical Meeting on Terahertz Science & Technology http://www.old.myeos.org/events/tst2018	C.M. Maissen (NGU)	Synthetic optical holography for phase resolved terahertz nanoimaging at sub-50 nm resolution
8 – 13. 7. 2018	Poster	Academia / industry	150 / 10	Plasmonics and Nanophotonics (GRS) https://www.grc.org/plasmonics-and-nanophotonics-grs-conference/2018/	Curdin Maissen (NGU)	Phonon-polariton based nanosplit ring resonators
23 – 27. 7. 2018	poster	academia	100	ICN+T Brno 2018 http://www.icnt2018.org/	Michal Kvapil (BUT)	Spontaneous silicon substrate oxidation after FIB milling probed by mid-infrared plasmonic antennas
	oral				Vlastimil Křápek (BUT	Babinet's principle for disc-shaped plasmonic antennas
	poster				Shu Chen (NGU)	Acoustic graphene plasmon nanoresonators for field enhanced infrared molecular spectroscopy
26 – 31. 8. 2018	posters	Academia / industry	150 / 10	The 15th International Conference on Near-Field Optics, Nanophotonics and Related Techniques http://nfo15.utt.fr/	D. Madhi (NGU)	Synthetic THz nanoholography for imaging CVD Graphene
					C. Maissen (NGU)	Phonon-polariton based nano-split ring resonator
					S.Chen (NGU)	Acoustic graphene plasmon nanoresonators for field enhanced infrared molecular spectroscopy
					A. Govyadinov (NGU)	Probing low-energy hyperbolic polaritons in van der Waals crystals with an electron microscope
2 – 7. 9. 2018	poster	Academia	300	Joint European Magnetic Symposia https://jems2018.org	Michal Kern, USTUTT	Integration of molecular quantum bits with semiconductor spintronics
10 – 13. 9. 2018	oral	academia	100	40th Conference of the Fachgruppe Magnetische Resonanz of the German chemical society	J. van Slageren (USTUTT)	Improving the sensitivity of THz frequency domain magnetic resonance

20 – 26. 10. 2018	poster	academia	150	European Conference on Molecular Spintronics 2018 http://icmol.es/ecmols2018/	M. Kern (USTUTT)	Integration of molecular quantum bits with semiconductor spintronics

Overview of PETER dissemination on conferences during M13-M42						
2. – 7. 1. 2019	poster	academia	50	Nanometa 2019, Seefeld, Austria	S. Chen (NGU)	Acoustic graphene plasmon nanoresonators for field enhanced infrared molecular spectroscopy
31. 3. – 5. 4. 2019	oral	academia	100	DPG 19 (DPG-Frühjahrstagung der Sektion Kondensierte Materie, 2019) https://regensburg19.dpg-tagungen.de/	V. Křápek (BUT)	Electric, magnetic, and electromagnetic hot spots
23 – 31. 5. 2019	poster	academia	100	SPP9 (Copenhagen, Denmark)	Shu Chen (NGU)	Antenna tips for sub-15nm resolving THz nanoscopy
1 – 8. 6. 2019	Invited lecture	academia	50	International Summit on OPTICS, PHOTONICS AND LASER TECHNOLOGIES; San Francisco	T. Šikola (BUT)	Quantitative Phase Imaging of Fields Shaped by Plasmonic Metasurfaces
13. – 17. 6. 2019	Invited lecture	academia	50	9th International Multidisciplinary Conference on Optofluidics; Hong-Kong	T. Šikola (BUT)	High resolution quantitative phase imaging
20 – 27. 7. 2019	Invited lecture	academia	100	International Congress on Advanced Materials, Sciences and Engineering, Japan	T. Šikola, J. Spousta (BUT)	Mid-IR Plasmonic Antennas on Absorbing Substrates: Optimization of Localised Plasmon-Enhanced Absorption upon Strong Coupling Effect
16. 7. 2019	Seminar lecture	Academia	30	University of California Santa Barbara (US)	A. Leavesley (TK)	HF EPR and the PETER project
15. – 18. 9. 2019	poster	academia	250	7th European Conference on Molecular Magnetism, Florence, Italy http://www.ecmm2019.org/	J. Čechal (BUT)	Deposition of molecular magnets by atomic layer injection
25.10.2019	Seminar	Academia	25	University of Bern (Switzerland)	A. Leavesley (TK)	Quasi optical approaches to EPR
30. – 31. 3. 2020	Workshop	Scientific community	50	Magnetic molecules on surfaces workshop, COSMICS, Paris, France	Dominic Bloos (USTUTT)	Presenting first results in EPR
8.-14. 03.2020	Poster	Scientific community	150	Nanolight 2020, Centro de Ciencias de Benasque Pedro Pascual, Benasque, Spain	Elizaveta Nikulina (NGU)	Antenna tips for sub-15 nm resolving THz nanoscopy
9. 3. 2021	Workshop	Scientific community	50	COSMICS online workshop	Lorenzo Tesi (USTUTT)	High Frequency EPR: New Tools for Investigating Thin Layers of Molecular Magnets
15. 4. 2021	Online conference	Scientific community	150	The 54th Annual International Meeting of the ESR Spectroscopy Group of the Royal Society of Chemistry	Lorenzo Tesi (USTUTT)	High Frequency ESR: New Tools for Investigating Thin Layers of Molecular Magnets

12. 5. 2021	Workshop	Scientific community, Industry	50	MetaLight'21, Brno, Czech Republic	Martin Hrtoň (BUT)	Modeling PE EPR
11. 6. 2021	Conference	Scientific community	100	International Conference of Molecular Magnetism (ICMM) 2021 - Rising Stars Conference	Lorenzo Tesi (USTUTT)	High Frequency EPR: New Tools for Investigating Thin Layers of Molecular Magnets

ANNEX 2 – LIST OF PRESENTATIONS DISSEMINANING PETER RESULTS ON PETER WORKSHOPS

Day	Event	Presenter	Title
3. 10. 2018	PETER Summer school	Tomáš Šikola (BUT)	PETER project introduction
16. 6. 2019	1st International PETER Workshop	Joris Van Slageren (USTUTT)	Plasmon Enhanced THz Electron Paramagnetic Resonance
17. 6. 2019	1st International PETER Workshop	Alisa Leavesley (TK)	Pulsed EPR: Instrumentation and Practice at High Magnet Fields
19. 6. 2019	1st International PETER Workshop	Lorenzo Tesi (USTUTT)	Molecular Spin Qubits studied by EPR and Thz Spectroscopy
16. 3. 2021	2nd International PETER Workshop (online)	Joris Van Slageren (USTUTT)	Introduction of PETER project
16. 3. 2021	2nd International PETER Workshop (online)	Richard Wylde (TK)	Quasi optic ideas and components
16. 3. 2021	2nd International PETER Workshop (online)	Joris Van Slageren (USTUTT)	Electron Paramagnetic Resonance in Molecular Nanomagnetism
16. 3. 2021	2nd International PETER Workshop (online)	Martin Hrtoň (BUT)	Modelling of PE EPR
17. 3. 2021	2nd International PETER Workshop (online)	Lorenzo Tesi (USTUTT)	Plasmonic Metasurface Resonators to Enhance Terahertz Magnetic Fields for High Frequency Electron Paramagnetic Resonance
18. 3. 2021	2nd International PETER Workshop (online)	Shu Chen (NGU)	Terahertz nanoimaging of chalcogenide phase-change materials
18. 3. 2021	2nd International PETER Workshop (online)	Elizaveta Nikulina (NGU)	Probes fabrication for ultrasensitive THz nanoscopy
18. 3. 2021	2nd International PETER Workshop (online)	Alisa Leavesley (TK)	The hardware behind PETER
18. 3. 2021	2nd International PETER Workshop (online)	Martin Konečný (BUT)	Scanning Probe Microscopy in Plasmon Enhanced Terahertz Electron Paramagnetic Resonance Spectroscopy