DATA MANAGEMENT PLAN: FWO-NAFOSTED PROJECT G0DAX23N

ADMINISTRATIVE INFORMATION

Project title: Synergy between top-down and bottom-up fabrication in plasmonics by embedding nanoclusters in metamaterials

Project Identifier: G0DAX23N

Researchers: Ewald Janssens, Joris Van De Vondel (QSP, Department of Physics and Astronomy, KU Leuven) & Nguyen Thanh Tung (Institute of Materials Science - IMS, Vietnamese Academy of Science and Technology - VAST, Hanoi, Vietnam)

Project summary: In the field of optics both nanoclusters, sustaining localized surface plasmon resonances, and metamaterials, facilitating localized electric and/or magnetic resonances, have received a lot of attention. Their study deals with fundamental scientific questions about strong light−material interactions such as enhanced scattering and highly localized electric fields and is of high relevance for applied research that makes use of a wide range of extraordinary electromagnetic properties such as negative refraction, perfect absorption, and reduced light speed. The synergy of plasmonic clusters with metamaterials will result in an even better control and subtle manipulation of light. Nevertheless, the embedding of nanoclusters in metamaterials is larger unexplored territory because of fabrication barriers due to their different size scales. In this project, we make hybrid nanocluster-metamaterial systems by combining the novel and highly controllable technique of cluster beam deposition with e-beam lithography. The electromagnetic behavior of this hybrid material with depend on the size and the concentration of the nanoclusters. The proposed research plan will allow i) to achieve a good understanding of optical properties of nanocluster-based metamaterials, ii) to understand the dynamic dissipation processes following light absorption in those hybrid systems, and iii) to make use of their strong near-field enhancement for sensing applications.

The project consists of five work packages, three scientific and two management work packages:

- WP1: growth and characterization of nanocluster embedded metamaterials
- WP2: dissipation processes following radiation absorption in the nanocluster-based metamaterials
- WP3: near-field enhancement for sensing applications
- WP4: Dissemination and outreach
- WP5: Project management

Institution: KU Leuven and IMS VAST; this Data Management Plan deals mainly with the data management for the KU Leuven part of the project.

RESEARCH DATA SUMMARY

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

This project will generate **new data**. There is no personal data involved.
Primary new data consists of analogue data (samples, laboratory logbooks, researchers' notebooks) and digital data (estimated volume of tens of GB/year). The digital data includes experimental data (ASCII data files containing numerical data from spectrometers and text metadata with instrumental parameters) and output files of the simulation software (ASCII/text files). Secondary data files consist of processed and analyzed experimental and simulation data; text documents, spreadsheets and graphical representation of data, used for (or resulting from) data analysis.

Type of data	Format	Volume	How created	WP
Mass spectra	.txt .csv	1-10 GB	Time-of-flight mass spectrometry measurements of nanoclusters	1
Spectroscopy data of metamaterial samples	.dat, .csv	1-10 GB	Spectroscopic measurements: FTIR, UV-VIS, Raman spectroscopy	1
Microscopy images	.tif, .jpg	<100 GB	Optical and electron microscopy characterization of the samples	1
Pump-probe spectroscopy data	.txt .h5	1-10 GB	Transient transmission/reflection data measured at FELIX in Nijmegen	2
Spectroscopic sensing results	.dat .csv	1-10 GB	Surfaces enhanced Raman spectroscopy data (this data will be created and stored at IMS, VAST)	3
Electromagnetic simulations	.out .opj .dat	1 - 5 GB	Simulations using COMSOL, CST, Matlab using FIT, FDTD, and FEM techniques. This data will be created and stored both at KUL and IMS, VAST.	1-3
Relevant reviewed literature	.pdf, .bib	10-100 MB	The articles may be stored in pdf and the selection of articles can be exported as a .bib file using the reference manager Mendeley.	1-3
Lab books with details about the different process trials, results, and observations.	Hand written	/	Written by the researchers in the lab.	1-3
Physical samples	Physical	/	Fabricated by the researchers in the lab.	1-3

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? If so, refer to specific datasets or data types when appropriate and provide the relevant ethical approval number.

- No

When research involves living animals, human participants, or when there is a possibility for dual use or misuse for unethical purposes, ethical approval needs to be obtained. Include your ethical approval reference number in the comment section.

- Not applicable

Will you process personal data? If so, please refer to specific datasets or data types when appropriate and provide the KU Leuven or UZ Leuven privacy register number (G or S number).

- No

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, …)? If so, please comment per dataset or data type where appropriate.

- No, but with following remark: Although tech transfer and valorisation are no direct goals of this project, if an opportunity presents itself, it will be discussed among the PIs involved in the project. The conclusions of that discussion will be appended to this data management plan.

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material or Data transfer agreements, Research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- There is no 3rd party agreement that restricts exploitation of dissemination. Since this project is a collaborative project, a partnership agreement has been concluded among the PIs of KUL and IMS, VAST that stipulates the exploitation and dissemination of the data.

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

DOCUMENTATION AND METADATA

*Clearly describe what approach will be followed to capture the accompanying information necessary to keep **data understandable and usable**, for yourself and others, now and in the future (e.g. in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, codebook.tsv etc. where this information is recorded).*

- For each experiment, a detailed (electronic) logbook will be used (different logbooks for the different experimental setups). These logbooks will contain the date, a brief description of the performed experiment, the parameters used for each measurement, as well as the names of all the saved files. The names of the files will be structured in a comprehensible way: system studied/date/main parameters used.

- In addition, data will be stored in a folder per experimental setup, the type of investigated system and the corresponding date. In this way, by tracking the corresponding logbook notes, each file can be easily found on the local computers controlling the setup and on the server of the laboratory.

- The analysis files will contain notes describing the analysis procedure and mention which original data files are included. A readme file describing the goal of the experiment and the analysis procedure will be stored in the folder where the data is saved.

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify which metadata standard will be used. If not, please specify which metadata will be created to make the data easier to find and reuse.

- No. In this research field, there is no formal metadata standard. However, the standardized steps described above will ensure that the data is easy to find and reuse.

DATA STORAGE & BACK-UP DURING THE RESEARCH PROJECT

Where will the data be stored?

- The data at KU Leuven will be stored on a shared network drive (R-drive) as well as on personal network drive synchronized with OneDrive-KU Leuven.

- At IMS, VAST, the data will be stored on a laboratory-level shared drive as well as on PI's hard drive.

- Selected files that need to be assessed by the partners in Leuven and Hanoi (like summarizing presentations, analysis files of experiments that will be included in publications), will be placed on a google docs folder.

How will the data be backed up?

- At KU Leuven, the data on personal computers is placed in OneDrive folders. The data stored on the local computers is continuously and automatically backed-up on local servers. This is taken care of by the IT responsibles of the department.

- Also at IMS, VAST an automatic back-up procedure is implemented.

Is there currently sufficient storage & backup capacity during the project? If no or insufficient storage or backup capacities are available, explain how this will be taken care of.

- Yes: The amount of data that will be generated in this project should not exceed hundred GBs, which is small enough to be stored in local computers and on local servers.

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

- At KU Leuven, the data will be systematically transferred to the local server, with restricted access (managed by the IT responsible). Only the (co-)promotors and involved researchers have access to the shared folders where the data, analysis files and reports will be stored. Also, credentials are required to log in to local computers in the laboratories.

- Access to the shared files on the google docs folder will be password protected.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

- The amount of data storage. Since data volumes in this project are not large, they are expected to fall within the offered amount. costs are small. The departmental IT plan that is being rolled out will for each researcher cover a basic

DATA PRESERVATION AFTER THE END OF THE RESEARCH PROJECT

Which data will be retained for 10 years (or longer, in agreement with other retention policies that are applicable) after the end of the project? In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).

- All data will be preserved for 10 years according to KU Leuven RDM policy. Also at IMS, VAST data will be stored for at least 10 years.

Where will these data be archived (stored and curated for the long-term)?

- Lab books will be stored in dedicated cabinets in the laboratories. Digital data will be retained on One-drive folders that are synchronized with the local storage. Physical samples are stored in desiccators for at least 5 years after the end of the research. In addition, all information required to reproduce sample fabrication is carefully logged. Note that longer storage of physical samples is meaningless as most samples will during aging undergo changes.

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

- The cost for data preservation during the retention period are comparable to the cost for storage and backup during the project. The same conditions apply.

DATA SHARING AND REUSE

Will the data (or part of the data) be made available for reuse after/during the project?
Please explain per dataset or data type which data will be made available.

- Depending on each specific research result, we will consider the option to make the data available as open data on RDR or another platform. This particularly makes sense for analyzed data like pump-probe transmission spectra, FTIR spectra, and SERS spectra. Data that is not made available as open data, will be made available if requested by the editor or publisher of a scientific journal or upon request of an individual (e.g. a researcher who intends to reproduce an experiment).

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)?

- No

Where will the data be made available? .

- KU Leuven RDR (Research Data Repository). In a restricted access depository. Upon request and after the agreement of the project's PIs, all data can be made available on an open repository, for example if requested by the editor or publisher of a scientific journal or via restricted access upon request of an individual (e.g. a researcher who intends to reproduce an experiment).

When will the data be made available?

- Upon publication of research results and after agreement of the involved PIs (with a possible embargo time no longer than one year after the publication of the research)

Which data usage licenses are you going to provide?

- This is not decided yet and will be discussed case by case, but most likely we will opt for a CC license.

Do you intend to add a persistent identifier (PID) to your dataset(s), e.g. a DOI or accession number? If already available, please provide it here.

- Yes, a PID will be added upon deposit in a data repository.

What are the expected costs for data sharing? How will these costs be covered?

- The cost of sharing is expected to be zero or low. In case there is a cost, it will be covered by working budget of the project.

RESPONSIBILITIES

Who will manage data documentation and metadata during the research project?

- Each researcher who collects data within the project, according to the standards that have been agreed upon.

Who will manage data storage and backup during the research project?

- At KU Leuven, data storage and backup is managed by the departmental IT. At IMS, VAST, data storage and backup is taken care of by the department of general administration.

Who will manage data preservation and sharing?

- Data preservation is managed by the departmental IT. Data sharing falls under the responsibility of the PIs: Ewald Janssens at KU Leuven and Nguyen Thanh Tung at IMS, VAST.

Who will update and implement this DMP?

- Ewald Janssens.