

fit4nano

Newsletter # 1 - November 2022

Grant Period 2 Review

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Editorial

It is my pleasure to welcome you all to the first newsletter of the Focused Ion Technologies for Nanomaterials (FIT4NANO) COST Action. As the newly assigned leader of the Communication and Outreach Working Group, I would also greet you on behalf of the Action coordinator, Gregor Hlawacek, as well as our colleagues of the core management group.

After two years of FIT4NANO, we have generated a number of news and events worth reporting about, which, more importantly, are the result of scientific and technological exchange and synergies between the FIT4NANO members. We have grown to more than 200 members, spanning across almost all European countries and beyond, while remaining open to all researchers interested in joining and benefiting from FIT4NANO. Please enjoy this newsletter contents and make sure you check your agenda and actively contribute to the coming activities.

Gemma Rius, Institute of Microelectronics of Barcelona (IMB-CNM-CSIC)



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www.fit4nano.eu



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FIT4NANO Membership - Working Group Applications

Back when we started our action in 2019, COST did not offer a membership management system. This is why our early members all had to sign up using a google form maintained by the Grant Holder. With Grant Period 2, COST changed the system and enabled membership applications for COST actions via their own e-COST infrastructure. Suddenly we had two lists on our hands and had to merge our old one to the new system. Due to data privacy laws, we were not allowed to simply sign up all of our existing members. We sent around a few e-mails and reminders about this already, but not everyone has gotten the memo, yet. So please, if you haven't done so already, please sign up and become a full member of FIT4NANO:

Step 1: Go to <https://e-services.cost.eu/> and log in or create your own account.

Step 2: Apply to join one, two, three, or all four of our working groups
<https://e-services.cost.eu/action/CA19140/working-groups/apply>

Why is it so important that you all sign up? Part of the budget allocated to us by COST for each Grant Period is based on the number of COST countries involved in the action, but the budget is also determined by the actual number of members. According to COST you are not a full member until you sign up in e-COST!

Working Groups *	<input type="checkbox"/> 1. Tool development <input type="checkbox"/> 2. Ion-solid interactions <input type="checkbox"/> 3. Application of FIB to nanostructured functional materials <input type="checkbox"/> 4. Communication and outreach
Scientific Background *	<input type="text"/> <small>Maximum 150 words: please describe here in a brief manner your scientific background relevant for the COST Action.</small>
Motivation *	<input type="text"/> <small>Maximum 150 words: please describe here in a brief manner your motivation to join the COST Action.</small>
Working Group Contribution *	<input type="text"/> <small>Maximum 150 words: please describe here how you plan to contribute to the Working Group(s).</small>
	<input type="checkbox"/> I'm available to be nominated as MC member <small>Please contact in parallel the COST National Coordinator (CNC) of your COST Member Country (COST National Coordinators) for your nomination.</small>
	<input type="checkbox"/> I'm available to substitute the MC member/observer of my COST member country or Specific Organisation on an ad-hoc basis

Screenshot of the e-COST website showing the working group application form © COST

FIT4NANO acknowledgment in publications

Official acknowledgment: *This article/publication is based upon work from COST Action FIT4NANO CA19140, supported by COST (European Cooperation in Science and Technology).* <https://www.cost.eu/>

If your work is a result from an STSM: *Financial support through a short term scientific mission funded by the COST Action CA19140 is acknowledged.* <http://www.fit4nano.eu/>

All others: *The authors are (partly) members of the COST Action FIT4NANO CA19140.* <http://www.fit4nano.eu/>

Please use the first one for all publications that are a result of a collaboration between two or more international FIT4NANO partners. Should you also have received financial support from us, please add the second (both statements are required).



fit4nano Project news

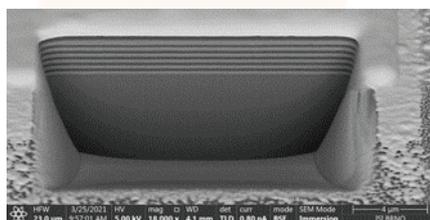
FIT4NANO Summer School 2022 Report

The 1st FIT4NANO Summer School on FIB fundamentals and application took place from 20 - 24 June 2022 in Brno, Czech Republic. Brno was chosen as it probably has the highest density of FIB instruments in the world! Due to the pandemic and to enable more people to take part in the lectures, the school took place in hybrid form with 50 online participants and 15 hands-on participants from all over Europe.

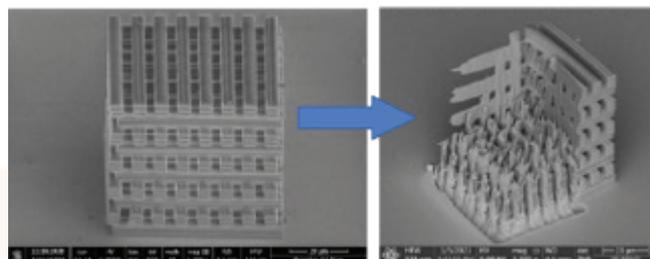
The aim of the Summer School was to equip early-career scientists with practical FIB operation experience and theoretical basics as well as to facilitate the networking of European scientific institutions on a personal basis.

In the mornings, the students attended lectures on the topics of Hardware, Theory, Simulation, Biology, and 3D applications. The lectures were given by experts from HZDR, HZB, and UFZ. The full program can be viewed at <https://fit4nano.eu/summer-school-2022/>

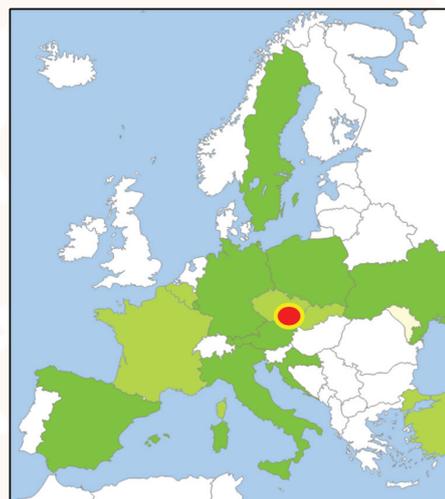
The afternoons were filled with practical exercises for the hands-on participants with 4 FIB microscopes and company demos (plasma FIB) from Tescan Orsay and Thermo Fisher Scientific.



Multi-layer structure consisting of alternating TiO₂/SiO₂ nano-layers, cross-sectioned by FIB. This structure is used for energy-saving spectrally-selective coatings (e.g. in solar thermal collectors) that help reduce our dependence on fossil fuels. ©Laborataris of Electron Microscopy, Institute of Scientific Instruments of the CAS, v. v. i.



A „stack of logs“ created by two-photon lithography, cross-sectioned by a focused ion beam. This structure serves as a test model for fine-tuning the two-photon polymeration process used for creating fine-detailed holographic prints for counterfeit protection. Done at Helios G4 FIB SEM (Thanks for support of ThermoFisher Scientific in BRNO) © Laborataris of Electron Microscopy, Institute of Scientific Instruments of the CAS, v. v. i.



Map showing the countries represented at the summer school © Laborataris of Electron Microscopy, Institute of Scientific Instruments of the CAS, v. v. i.

FIT4NANO will organize another summer school in 2024.



The summer school students and lecturers that traveled to Brno © Laborataris of Electron Microscopy, Institute of Scientific Instruments of the CAS, v. v. i.



WG4 Communication and Outreach

New WG4 leader

Gemma Rius new WG leader in GP3

Gemma Rius will take over the role of Working Group 4 leader in GP3 (November 2022 – October 2023).



© G. Rius

FIT4NANO Video Clip Production

Volunteers wanted for Task Force

We are planning on making our very own video clip - animated, live-action, or stop-motion?! The possibilities are endless!

The plan is to find a suitable storyline in GP3 and create a storyboard, which will be turned into a movie in GP4. If you are interested in science communication and creating a movie clip, this is your chance!

Please contact Gemma at gemma.rius@csic.es to find out more about the task force.

Grant Period 2 Report

In the beginning of last grant period Amy Gandy, our WG4 leader in the first grant period, stepped down from her position. Several attempts were made by the Grant Holder to recruit a new lead early on, but with no success. This left a lot of the work planned for GP2 undone.

Things just picked up speed during the 2nd FIT4NANO workshop in Krakow in July, when several old and new FIT4NANO members showed interest in taking an active part in WG4. As there was very limited time allocated to the working group meetings during the workshop, it was agreed that a meeting in presence dedicated to WG4 should take place at the end of GP2 to kick-start new activities and to distribute the responsibilities for the individual tasks (like creating this long overdue newsletter).

[Read more about WG4 in the WG4 meeting report.](#)

Selected Outreach Activities during GP2

(the full list is available at <https://fit4nano.eu/publications/>)

FIT4NANO member	Affiliation	Type of Outreach	Title
Wolfgang Lang	University of Vienna, Austria	Invited talk at AVS67	Nanoscale vortex pinning structures in high-temperature superconductors created in a helium ion microscope superconductors: a tool for flux quanta manipulation
James Whitby	Tofwerk, Switzerland	Oral presentation at ALC22	FIB-SIMS for the characterization of rechargeable batteries
Wolfgang Lang	University of Vienna, Austria	Conference Presentation at MNE2021	Nanoscale patterns in copper-oxide superconductors created in a helium ion microscope
Gemma Rius	IMB-CNMCSIC, Spain	Online Poster	European corner – project presentation
Iacob Andreea Teodora	University of Medicine & Pharmacy "Grigore T. Popa", Romania	Oral presentation at NanoBio-Mat 2022	Biomimetic chitosan/PEO nanofibers as non-cytotoxic wound dressings
Gregor Hlawacek	HZDR, Germany	Oral presentation at EPS Forum	Materials and emerging technologies for a digital world
José María de Teresa	INMA, Spain	Outreach talk at Pint of Science	Presentation on Electronics and Neuroscience
José María de Teresa	INMA, Spain	Outreach talk	Presentation on microchips – current and future use of microchips



WG4

Communication and Outreach

WG4 Meeting in Barcelona

A hybrid WG4 Meeting took place on 3-4 October 2022 in Barcelona, Spain. FIT4NANO members, who had shown interest in taking active responsibilities at the FIT4NANO workshop in Krakow, were invited to attend the meeting in person, all other WG4 members were invited to attend remotely.

The two-day meeting covered topics such as WG4 leadership rotation, Material for high school lecture, Science Communication, Role models, guidelines for blog / video entries for upcoming STSMs in GP3 and onward, as well as methods for project presentation for layman and other target groups (posters, videos, comics).

WG4 leadership rotation

While there can be only one leader, many people will be actively involved in running WG4. To honor this, a leadership rotation will be introduced with Gemma Rius being the official WG4 leader in GP3 with Genta Rexha and Delina Xhafaj taking over in GP4 and GP5, respectively.

Material for High School Lectures

Screenshot! Silvia Schintke created material including a quiz for an introductory high school lecture on FIB. The draft was discussed and will be adapted to be ready in GP3. The initial material was already tested once and will do another test run at a high school in Germany.

When the English and German material is ready, it will be shared with FIT4NANO members for translation into other languages and than for distribution to local high schools.

Newsletter

You are now reading the very first edition of our bi-annual newsletter. We will report on everything that happened in the past or current grant period and make announcements for upcoming events.

For this, we will need your help! If you would like to contribute with anything newsworthy that happened to you in the past ~6 months, such as graduations, publications, awards, projects or other news, please fill in the dissemination survey at

<https://forms.gle/3tzJKH5CQi9GehqB8>

If you are uncomfortable using Google forms, you can also send an e-mail to Astrid at a.berens@hzdr.de

Guidelines for STSM reports

In order to increase the visibility of the action as well as the STSMs itself, it will be mandatory for STSM grant recipients to submit a publishable report including photos for the FIT4NANO website & newsletter. Alternatively, a self-made video clip of your STSM will also be accepted.

Grants will only be paid after this is submitted.

A first draft of what the guidelines could look like and what should be included in the reports was finished during the WG4 meeting and will be distributed in the core group for editing and approval before being published.

FIT4NANO Video Clip

We are planning on publishing a video clip in GP4 (starting in November 2023). To prepare for this, the plan is to create a video clip task force, mainly from PhD and Early Career researchers, in GP3 - so now! If you are interested in getting creative and in Science Communication in general, please contact Gemma.

The goals for GP3 are to find a suitable topic for the clip, to create a draft for a storyline, to research suitable companies to help us with the project, and, finally, to pick one of these companies.



WG4 meeting in action © S. Lymperoupoulu

Participants of the meeting:

Gemma Rius (new WG4 leader, IMB-CNM-CSIC, Spain), Genta Rexha (Albanian University), Svenja Lohmann (HZDR, Germany), Silvia Schintke (HES-SO University of Applied Sciences and Arts Western Switzerland), Astrid Berens (GHM, HZDR, Germany), Gregor Hlawacek (COST Action Chair, HZDR, Germany), Smaragda Lymperoupoulu (Science Communication Manager, FORTH, Greece), Jose Maria de Teresa (STSM Coordinator, CSIC, Spain), Katja Höflich (WG3 leader, Ferdinand-Braun-Institut, Germany), Delina Xhafaj (Albanian University), Maciej Pasniewski (EMAT, Belgium), Valentine Riedo (TOFWerk)



fit4nano STSM & other grants

Overview of Short-Term Scientific Missions in GP2

Grant Period 2 ran from from 01 November 2021 to 31 October 2022. In total, 11 STSM applications were approved in GP2, of which 7 actually took place:

-  Ewelina Gacka, Helium ion beam microscopy in fabrication of field emission-based MEMS, Wrocław University of Science and Technology, Poland, to HZDR, Germany (13 days)
-  Lucia Herrero, Direct-write nanofabrication of Pd meshes and interdigitated electrodes, Instituto de Nanociencia y Materiales de Aragón (INMA), Spain, to HZDR, Germany (12 days)
-  Gemma Rius, Nanopatterning of epitaxial Graphene on Silicon Carbide by Helium ion microscope for nano electronics, Institut Microelectronica de Barcelona (IMB-CNM-CSIC), Spain, to HZDR, Germany (5 days)
-  Bartosz Pruchnik, Focused ion beam technology in fabrication of diamond tip based scanning probe microscopy cantilevers, Wrocław University of Science and Technology, Poland, to University of Surrey, UK (14 days)
-  BJ Inkson, Exploiting Li-Focused Ion Beams for Battery Research, The University of Sheffield, UK, to HZDR, Germany (7 days)
-  Brian Kantor, Investigating material modifications induced by focused ion beam structured indium tin oxide films, University of Graz, Switzerland, to Helmholtz-Zentrum Berlin, Germany (19 days)
-  Nico Klingner, Feasibility study for single ion implantation and the verification by secondary electron detection, HZDR, Germany, to Orsay Physics, France (5 days)

STSM Report by Ewelina Gacka

Department of Nanometrology, Wrocław University of Science and Technology, Poland



© E. Gacka

Between 6th and 18th June 2022, I had the opportunity to visit the Helmholtz-Zentrum Dresden Rossendorf (Germany) at the Institute of Ion Beam Physics and Materials Research. It was the result of an awarded STSM grant during Grant Period 2, entitled 'Helium ion beam microscopy in fabrication of field emission-based MEMS', which was supervised by Dr. Hlawacek.

The visit concerned the modification by helium and neon

ion beams of microelectromechanical systems (MEMS): silicon microcantilevers and microbridges. MEMS consisted of a thin, suspended insulator layer (silicon oxide or silicon nitride, instrument layer) and conductive paths. An ion microscope was used to mill nanometer-sized holes in the metallization paths of the structures to electrically separate them from each other and prepare them for the deposition of field emitters. The calibration growth of the nanowires was then performed. A helium ion beam and a tungsten precursor were used for deposition. In the final step, nanowires, which act as a field emitter electrodes, were deposited opposite each other and between the previously milled holes (on two separated paths). The electrodes were biased to study the field emission phenomenon from structures deposited in a single step using an ion beam. In the future, the nanometre field emitters are intended to create a prototype of a deflection detector for MEMS structures.

It is also worth mentioning that the research conducted was enriched by free time spent exploring Dresden and walking around the Bastei. For providing a welcoming atmosphere of stay and work, special thanks to Dr. Gregor Hlawacek, Dr. Nico Klingner, Dr. Svenja Lohmann and Ms. Astrid Berens from HZDR, as well as M.Sc. Krzysztof Kwoka and Prof. Teodor Gotszalk, who supported me substantively.



STSM in Dresden (HZDR) by Lucia Herrer

from CSIC Zaragoza, Spain. May 2022



Part of Dresden City Center © L. Herrer

When going abroad for research, two weeks (in my case), seems like a very short stay. You should make the most of your time to reach the scientific goal and, for sure, to visit the city and the surrounding areas.



Dr. Lucía Herrer © L. Herrer

The main goal of this STSM was to make use of the Helium Ion Microscope to fabricate Pd-enriched nano- and microstructures bearing similar or improved resistivity values (compared to Ga⁺ and e⁻ beams), applying an easy direct-write procedure in conjunction with the capability of a higher resolution thanks to the He⁺ and Ne⁺ beam.

Besides the huge amount of data we registered, and the surprising results we got, I really appreciated the excellent reception by the Ion Induced Nanostructures research group. Even if it's a short stay, you are alone, and it is an unknown place. Luckily, they made me feel comfortable, including me in their daily routine. Undoubtedly, I want to highlight G. Hlawacek for his kindness. We worked hard together, he proved to have tons of patience (I'm an undercover chemist in a physicist's world, I think) and I learned a lot from him.

An anecdote, here in Spain Tuesday 13th is known as a day of bad luck. There, this day is Friday the 13th, and unfortunately, I had one. The very last day of my STSM, I missed the bus I used to take (the urban transport is

amazingly precise), I took the next one only three minutes later. This one has the same route but, I missed the stop at HDZR, the bus driver left me in the middle of nowhere and I had to return on foot, which took half an hour and it was early in the morning. It was a nice road but without a hard shoulder, it's just as well I didn't bring the luggage with me! After that, my entrance to the research center was not allowed because my access card had expired. Then, I had technical problems at lunchtime, and the day ended in a panic attack when I almost broke part of a microscope (but thankfully I didn't).

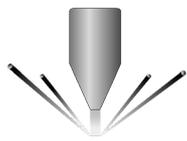


Morning Walk © L. Herrer



Basteibrücke © L. Herrer

Nevertheless, I had the weekend to have a look at this beautiful city. I enjoyed the free tour, and also the cool live music I found in different squares. The weather was perfect, better than I expected, and I was also able to go cycling as far as Basteibrücke, through the Elbe Cycle Route. In my opinion, these COST grants are a solid support to facilitate the scientific networking and the broadening of the knowledge. Being an excellent scenario to generate new and fresh ideas.

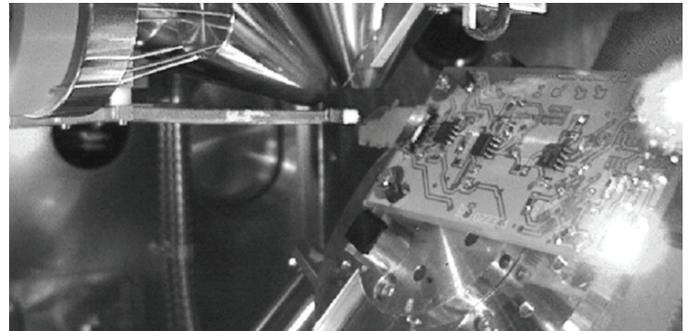


STSM Report by Bartosz Pruchnik *Wrocław University of Science and Technology*

I had the opportunity to visit laboratories of Advanced Technology Institute of University of Surrey under the supervision of Dr David Cox as a result of awarded STSM grant "Focused ion beam technology in fabrication of diamond tip based scanning probe microscopy cantilevers". During my two week stay, I had the possibility to learn and utilize Dual Beam Microscope (FIB-SEM) Tescan FERA3 with Xe⁺ plasma ion source.

The main goal of the visit was to learn and produce sharp diamond tips for active piezocantilevers. Cantilevers I brought from Department of Nanometrology together with boron-doped diamond particles. Tips were manufactured with use of FIB-SEM microscope and its equipment. Use of xenon ion beam reduced time necessary to perform most of the operations, therefore, accelerating process whatsoever. Active piezocantilevers were embedded in electronic circuit for precise electrical deflection measurement. Observation of resonant frequency of cantilevers brought possibility to assess mass change of the cantilever. Information about mass further enhanced process flow. Results of enhanced manufacturing process were presented during the EUFN 2022 workshop on poster "High throughput tip manufacturing for active piezocantilevers with xenon ion beam with mass control". During the STSM, five diamond tips were manufactured.

Apart from tips manipulation, thanks to measurement setup, it was possible to perform a few experiments with mass measurement of deposited material. Piezocantilevers were used to determine mass of deposited material with resolution down to below 1 pg.



© B. Pruchnik

The visit would not have been successful without the great scientific supervision of Dr David Cox and the help of his student, Mateus Masteghin, who was a great teacher of microscope usage. Electronic circuits were prepared by PhD student Dominik Badura from Department of Nanometrology. The STSM would also not have been possible without Prof. Teodor Gotszalk support.

New STSM Call for Grant Period 3

Applications for the first call of GP3 can be submitted in e-COST until 15 December 2022. Before you do so, please take the time to read the rules carefully.

Accepted STSMs can take place between 15 January 2023 and 31 October 2023*.

New in this GP is that all STSM applicants have to hand in a budget with their expected costs along with their application. In addition to the STSM report for e-COST, accepted STSM grantees are to write a more general report about their stay and experience for the website & newsletter, similar to what you see in this newsletter (thank you to Lucia, Ewelina, and Bartosz to graciously agree to write something for us!). The report should be around 1/2 - 1 Din A4 page and cover questions like

*Why did you choose XY as the host institution?
What was the scientific question you tried to answer?
What challenges did you meet during your STSM?*

*What was your biggest success and the worst failure?
What will you do next?
What did you learn about the host country/city/culture?
How did you like the experience in general?*

The call is available on the FIT4NANO website at <https://www.fit4nano.eu/4th-stsm-call>

The COST Annotated Rules can be found at

<https://www.cost.eu/uploads/2022/10/COST-094-21-Annotated-Rules-for-COST-Actions-Level-C-V1.3-.pdf>

* Be aware that STSMs that finish late in October will have less time to submit their reports due to the fact that the grant period review begins on 1 November and all payments have to be processed by mid-November at the latest.



fit4nano STSM & other grants

Overview of non-STSM grants in GP2

In Grant Period 2, four grants were awarded in addition to the STSM grants.

-  Virtual Networking Support Grant: 1 – Müslüm Kaplan
-  ITC conference grants: 2 – Katarzyna Madajska and Aleksandra Butrymowicz for attending FEBIP 2022
-  Dissemination conference grant: 1 – Gregor Hlawacek for attending the EPS Forum

ITC conference grants support Early Career Investigators and PhD students from participating ITC to attend related conferences or events that are not organised by the COST Action. The Dissemination Conference Grants are for supporting official FIT4NANO members presenting the Action, its activities, and results at high-profile conferences. The oral contribution needs to cover a topic relevant to the Action and contribute to the development of new contacts and potential future collaborations.

FIT4NANO will offer a limited amount of these grants again in GP3, so please apply early. In order to apply, you will need to have an e-cost account and be a member of FIT4NANO.

ITC Conference Grant Report by Katarzyna Madajska and Aleksandra Butrymowicz

Thanks to the financial support under the ITC Conference grant granted thanks COST Action (CA19040), we were able to participate in the 8th FEBIP workshop of the Focused-Electron-Beam-Induced-Processing (Krakow, Poland, 13–15 July 2022).

The aim of our participation in this conference was to present research results on new copper and silver precursors for the production of nanomaterials by vapour deposition methods: CVD and FEBID. We each had a poster accepted by FEBID: “Study of key processes for finding new FEBID precursors” and “Copper(II) complexes with pivalate and small aliphatic amines as precursors for nanomaterial fabrication” (abstracts to the right)

The conference brought together specialists from all over the world to discuss problems in the field of electron beam induced processes. Participating in this event allowed us to learn about the latest reports and to establish new collaborations and exchange views with scientists from different countries. The opportunity to participate in the event was an important experience in scientific development. Thanks to this conference, we gained valuable

tips for further research work on the synthesis of new FEBID and precursors. In our opinion, programs such as ITC Conference Grants conducted as part of the COST Action are very necessary and allow PhD students to participate in specialized conferences that improve their qualifications.

Study of key processes for finding new FEBID precursors

Katarzyna Madajska¹, Iwona B. Szymańska^{1*}

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Gas assisted focused electron beam induced deposition (FEBID) is nanostructuring technique that is employed in electron microscopes. Thanks to this method it is possible to obtain metallic nanostructures with complex shapes in a simple, one-step process. Due to the high requirements for the precursor (among other things, adequate volatility, stability and also decomposition under the influence of the electron beam), problems still persist in obtaining materials consisting only of metal. Pure structures have been obtained for several elements, however, frequently used precursors are toxic or rapidly decompose under the influence of oxygen or moisture in the air. So far, both fluorinated and branched-chain silver carboxylates have been used in the FEBID process, obtaining structures with a purity of 59–76 at.% Ag. On the other hand, using copper(II) carboxylate $[Cu_2(O_2C_2F_5)_4]$, a purity of 23 at.% Cu was achieved. This shows that research is still needed to understand the interaction of compounds with electrons in order to select the appropriate ligands for FEBID precursors [1–3].

Therefore, it was decided to investigate the influence of the coordination center (Cu, Ag) and O-, N-, N- and N, O-donor ligands (Figure 1) on the volatility of the complexes and their decomposition under the influence of low- and high-energy electrons. Heteroleptic complexes containing two different ligands were also tested.

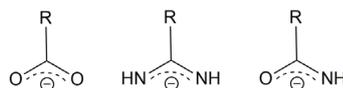


Figure 1. Structure of deprotonated ligands. From left to right: carboxylate, amidinate, amidate, R = perfluorinated group.

Volatility studies such as electron ionization mass spectrometry, variable temperature infrared spectroscopy, thermal analysis and sublimation experiments have shown that the new compounds can enter the gas phase without decomposition. High intensity molecular ions are observed in mass spectrometry for thermally stable compounds. To initially assess the sensitivity of complexes to the high-energy electron beam, observations were made using a scanning electron microscope (SEM, 20 keV) and a transmission electron microscope (TEM, 200 keV).

The study showed that volatility and electron beam sensitivity are influenced by both the coordination center and the ligands used. Interestingly, compounds that are more thermally stable are less sensitive to low- and high-energy electrons. Among the studied compounds, the heteroleptic complex $[Cu_2(NHCH_2CF_3)_2(O_2CCF_3)_2]$ is the precursor with the best parameters. The reaction between ligands induced by interaction with electrons is observed, which affects the further dissociation process.

[1] I. Utke, P. Swiderk, K. Höflich, K. Madajska, J. Jurczyk, P. Martinović, I. B. Szymańska, Coordination and organometallic precursors of group 10 and 11: Focused electron beam induced deposition of metals and insight gained from chemical vapour deposition, atomic layer deposition, and fundamental surface and gas phase studies Coordination Chemistry Reviews, 458, 213851 (2022).

[2] S. Barth, M. Huth, F. Jungwirth, Precursors for direct-write nanofabrication with electrons, J. Mater. Chem. C, 8, 15884 (2020).

[3] I. Utke, P. Hoffmann, J. Melngailis, Gas-assisted focused electron beam and ion beam processing and fabrication, J. Vac. Sci. Technol. B, 26, 1197–1276 (2008).

Copper(II) complexes with pivalate and small aliphatic amines as precursors for nanomaterial fabrication

Aleksandra Butrymowicz^{1*}, Katarzyna Madajska¹, Wiktorija Luba¹, Tadeusz Muzioł¹, Iwona B. Szymańska¹

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Vapour deposition methods such as focused electron beam induced deposition (FEBID) needs volatile and sensitive to the electron beam compounds for nanofabrication, capable of producing 2D and free-standing 3D structures of sub-10 nm size. Until now the development of FEBID precursors has relied on thermally induced chemical vapour deposition (CVD) precursors. The choice of the volatile and sensitive to the electron or ion beam precursor is crucial for nanostructure growth success. Chemical compounds used in FEBID should: a) characterized by high thermal stability and vapor pressure at low temperatures; b) dissociate completely to a predicted material as a result of interaction with the electron beam, c) form by-products, which easily desorb from the substrate surface. In the case of carboxylates using $[Ag_2(\mu-O_2C)_2]$, where R = Bu, C(Me)₂, C₂H₅, and C₂H₅ it was shown that these compounds can be dissociated through a focused electron beam to give deposits with a satisfactory metal content (57 at.%, 73 at.%, 70 at.%, and 76 at.%, respectively). However, for copper(II) $[Cu_2(\mu-O_2C-C_2F_5)_2]$ the fabricated material contains 23 at.% Cu [1], [2], [3].

Here we present the study of volatility and interaction of electrons with new, user-friendly, multinuclear copper(II) complexes with pivalate [2,2-dimethylpropanoate] and small aliphatic amines: RNH₂, where R = Bu, Bu, Pr, and Et and known in the literature $[Cu_2(Et)(\mu-O_2C-Bu)_2]$ [4], which can be an alternative to previously studied carboxylates. The purpose of introducing a secondary ligand to copper(II) pivalate was to check how it would change properties such as volatility and sensitivity to the electron beam. Based on variable temperature infrared spectroscopy VTIR (10⁻³ mbar) supported with TGA/DTA, the mechanism of thermal decomposition was determined. Bands characteristic of complexes, in the gas phase were observed in the range 160–240°C. The sublimation data provided that studied copper(II) compounds evaporate over the range 90–120°C. Thin layers were obtained by sublimation on a silicon substrate under reduced pressure (10⁻³ mbar). The prepared samples were exposed to a beam of high-energy electrons. These studies revealed a sensitivity to high-energy electrons and confirmed that the compounds are promising as FEBID precursors. Moreover, to confirm the effective formation of metal carriers, CVD deposits were fabricated with the use of new copper(II) compounds.

[1] I. Utke, P. Swiderk, K. Höflich, K. Madajska, J. Jurczyk, P. Martinović, I. B. Szymańska / Coord. Chem. Rev. 458, 213851 (2022).

[2] L. Berger, K. Madajska, I. B. Szymańska, K. Höflich, M. N. Polyakov, J. Jurczyk, C. Guerra-Núñez, I. Utke, Beilstein J. Nanotechnol. 9, 224 (2018).

[3] L. Berger, J. Jurczyk, K. Madajska, T. E. J. Edwards, I. B. Szymańska, P. Hoffmann, I. Utke, ACS Appl. Electron. Mater. 2, 1989 (2020).

[4] M. Mikurya, H. Azuma, R. Nukada, M. Handa, Chem. Lett., 57 (1999).

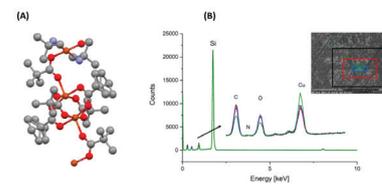


Figure 2. $[Cu_2(BuNH_2)_2(\mu-O_2C-Bu)_2]$ (hydrogen atoms omitted): (A) – the crystal structure, (B) – a thin layer of the complex obtained in the sublimation process, deposited on a silicon wafer and exposed to a beam of high-energy electrons.



FIT4NANO Announcements

STSM and VM Grants

Until 15 December 2022

The 4th STSM Call is now open and is accepting applications.

Find out more at

<https://www.fit4nano.eu/4th-stsm-call>

Likewise, a virtual mobility call for the FIB roadmap has been published and is accepting applications. If you have a talent and interest in graphic design, check out the call at

<https://fit4nano.eu/virtual-mobility-call-fib-roadmap-graph/>

Role Model Webinar

First months of GP3

FIT4NANO will offer a webinar on role models in Science in the beginning of GP3 (date to be determined! Several scientists will talk about their career and the unconventional way they got to where they are today.

3rd FIT4NANO workshop

Save the date!

17 – 19 July 2023

The 3rd FIT4NANO Meeting will take place in Lisbon, Portugal, and will be organized by Catarina Pinto Reis.

Check the FIT4NANO website to stay updated on all these events!

2nd FIT4NANO Workshop Report

The 2nd action workshop took place in Krakow, Poland from 11 to 13 July 2022 and was organized by Marta Marszalek (Institute of Nuclear Physics, Polish Academy of Sciences). The three day workshop was packed with 34 oral presentations and a poster session with 17 accepted posters. One morning session was reserved for FIT4NANO's annual Management Committee meeting and one afternoon was set aside for the working group meetings, where the FIB road map and the future of WG4 were discussed, among other things.

Among the seven invited speakers was Dr. Rosa Córdoba, ICMol, University of Valencia, Spain, who talked about "Additive nano-manufacturing of advanced superconductors, and devices using focused ion beam technology," research she conducted during a FIT4NANO STSM stay in 2021.

In total, 123 participants joined either in presence or remotely, of which 68 were official FIT4NANO members. Most participants were from COST member countries, but participants from Australia, Cameroon, Morocco, India, and the USA also attended.

The program and book of abstracts can be viewed at <https://fit4nano.eu/workshop-2022/workshop-program/>

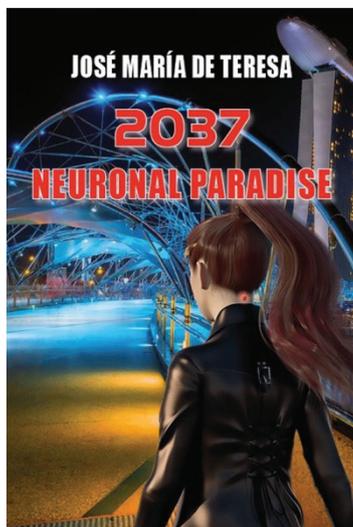


Impressions of the FIT4NANO Workshop. Photos: © A. Berens



fit4nano member news

Novel featuring Ion Beams by José María De Teresa



Book cover © J. M. de Teresa

Our very own STSM coordinator, José María De Teresa, wrote a technothriller novel called "2037. Neuronal paradise", featuring ion beams!

Official Blurb:

"Isabelle and Diego are two young scientists who cross their lives in Sânga-Säby, a small Swedish town where the Nobel Foundation has organized a scientific meeting. A few years later, they will establish in Montreal a promising innovative company in the field of neurotechnologies called CajalLink. However, the ambitious project they are carrying out is in danger due to the theft of the neurodata, which are collected in a small device the size of a grain of rice implanted in the neck. Thanks to the sagacity of Alice, a young CajalLink employee, they will be able to detect the threat and neutralize it. CajalLink's activities are relocated to Singapore, a country with laxer data protection and privacy legislation (a neuronal paradise). There, they carry out the most critical part of the project, aiming to develop the most powerful security tool that one can imagine. But a series of events puts the technology developed by CajalLink to the test. The threats that loom over the lives of the protagonists are enormous when the main world powers discover the potential of this new technology. Will Alice be able to unravel the enigmas surrounding CajalLink?"

The book is now available in Spanish and English. You can order a copy at your local Spanish bookstore or online for the English and the Spanish versions. Find out more at: <https://www.amazon.com/author/deteresa>
<https://nanofab-deteresa.com/science-popularization>
<https://inma.unizar-csic.es/en/2037-paraiso-neuronal>

New publications

Lucas Backmeister, Bernd Aichner, M. Karrer, K. Wurster, R. Kleiner, E. Goldobin, D. Koelle, Wolfgang Lang, *Ordered Bose Glass of Vortices in Superconducting $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$ Thin Films with a Periodic Pin Lattice Created by Focused Helium Ion Irradiation*, *Nanomaterials* 12, 3491, [DOI](#)

Pablo Orús, Fabian Sigloch, S. Sangiao, José María de Teresa, *Cryo-Focused Ion Beam-Induced Deposition of Tungsten-Carbon Nanostructures Using a Thermoelectric Plate*, *Applied Sciences*, volume 11, page 10,123, 2021 [DOI](#)

Alba Salvador-Porroche; S. Sangiao; C. Magén; M. Barrado; P. Philipp; D. Belotcerkovtceva; M. Venkata Kamalakar; P. Cea; José María de Teresa; *Highly-efficient growth of cobalt nanostructures using focused ion beam induced deposition under cryogenic conditions: application to electrical contacts on graphene, magnetism and hard masking*, *Nanoscale Adv.*, 2021,3, 5656-5662 [DOI](#)

Nico Klingner, K.-H. Heinig, D. Tucholski, W. Möller, R. Hübner, L. Bischoff, G. Hlawacek, and Stefan Facsko, *Epitaxial Lateral Overgrowth of Tin Spheres Driven and Directly Observed by Helium Ion Microscopy*, *J. Phys. Chem. C* 2022, 126, 38, 16332–16340, [DOI](#)

If you have questions, comments, or input for the next newsletter, please send an e-mail to Astrid at a.berens@hzdr.de

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