SEMICONDUCTOR PLATFORMS

JOB OFFERS

PhDs

January 2026

About CEA-Leti

Committed to innovation, CEA-Leti creates differentiating solutions for its industrial partners

CEA-Leti is a recognized global leader in miniaturization technologies. CEA-Leti's teams are focused on developing solutions that will enable future information and communication technologies, health and wellness approaches, clean and safe energy production and recovery, sustainable transport, space exploration and cybersecurity.

For more than 50 years, the institute has built long-term relationships with its industrial partners, tailoring innovative and differentiating solutions to their needs.

Its entrepreneurship programs have sparked the creation of 75 startups. CEA-Leti and its industrial partners work together through bilateral projects, joint laboratories and collaborative research programs.

CEA-Leti maintains an excellent scientific level by working with the best research teams worldwide, establishing partnerships with major research technology organizations and academic institutions. CEA-Leti is also a member of the Carnot Institutes network—a French network of 39 institutes serving innovation in industry.

Join CEA-Leti and benefit from:

- Resources to address major societal challenges
- Multidisciplinary networks to conduct your research
- World-class technological platforms
- An international scientific, high-skills environment
- The strength of a major public research organization

A global presence with offices in France, San Francisco, Brussels and Tokyo

€350
million annual operating budget

1,900
research engineers

3,200
patents in portfolio

600+
publications per years

11,000
square meters of cleanrooms

75+
startups created

ISO 9001
certified since 2000

A great place to study

The 2021 Shanghai Academic Ranking of World Universities named Grenoble-Alpes University #1 in France for:

- Nanoscience & Nanotechnology
- Metallurgical Engineering
- Water Resources Engineering
- Geography
- Hospitality and tourism management

The university's student population of 59,000 stands out for its diversity and excellence:

- 42% pursuing degrees in a scientific field
- 3,000 PhD students
- 1 in 6 students is a foreigner
- 150 different nationalities

Source: Invest in Grenobel Alpes, Grenoble-Alpes University

Grenoble: 5th most inventive city in the world *(Forbes magazine)*

#1 Grenoble Alpes is ranked #1 in France for its concentration of R&D jobs

25 ski resorts close to the city

CEA-Leti's Cleanrooms Platform

Manufacturing innovative devices for the industry

Main Activities

- More Moore microelectronics, Beyond CMOS & More than Moore
- Substrates and substrate engineering, including SOI and FD-SOI
- Power components
- MEMS and NEMS
- Non-volatile memory
- Imagers and displays
- Silicon photonics
- 3D integration

Key figures

- 11,000 m² space
- 600 research engineers
- 50 new patents a year

CEA-Leti's teams support the innovation needs of industrial partners across all or some stages of development, using bilateral contracts. Each collaboration is subject to an intellectual property agreement establishing the confidentiality of all work.
The platform works with more than fifty industrial partners: microelectronics stakeholders, fabless companies and equipment manufacturers, industrial users (telecoms, photonics, automobile equipment manufacturers, etc.)

With a world class microelectronic equipment pool, CEA-Leti's cleanrooms help develop procedures involved in manufacturing innovative components and electronic circuits compatible with the industry's high-volume requirements. CEA-Leti's cleanrooms are ISO 9001 certified and are in operation 24h/7.

More than 600 CEA-Leti experts in microelectronic processes (deposition, photolithography, etching, planarization, bonding, etc.), equipment, and materials are developing technologies and components for future products in collaboration with many industrial partners (lab-to-fab model) :

- resilient, competitive manufacturing processes with an optimized number of stages and environmental impact;
- customized, ready-to-use multistage modules for smooth transfers to our industrial partners' production machines;
- state-of-the-art prototypes in terms of miniaturization, energy efficiency, speed, frequency, and performance.

The platform relies on a pool of nano-characterization equipment that is unique in Europe, including electron microscopy, X-ray diffraction, magnetic resonance, ion beam processes.

Microsystems 200 mm & 300 mm Platform

A world-class R&D facility

Main Activities

- **Sensors**: Nav-grad inertial sensor, microphone, barometric pressure sensor, pMUT/CMUT, gas sensor, bio-sensor
- **Actuators**: haptic feedback, piezo-scanner, piezo-loudspeaker, GHz-range time reference resonator

Key figures

- 11,000 m² space (clean room)
- 150+ research engineers
- 30 patents per year
- 20+ industrial partners
- 6 startup creation

CEA-Leti's teams support the needs of its industrial partners (major groups, small and medium-sized companies, and startups) across all or some stages of development, using bilateral contractors or collaborative projects.
The platform hosts about twenty industrial partners from mobile phone medical, automotive, industry, aeronautics, special and defense markets.

The Microsystems 200 mm and 300 mm platform develops sensors, actuators, RF microsystems (MEMS-RF) and integrated packaging solutions.

The platform's highlyqualified staff, equipment, and international activities make it the world's leading center for high performance microsystems R&D. The objectives of the R&D conducted at the platform are to optimize the actual sensors and actuators, their integration, their reliability while reducing component cost and energy consumption to transfer them to industrial partners. The platform investigates also new materials in particular new piezoelectric material generations, creates, and develops new components with the associated technological channels.

The microsystems platform targets the mobile phone, medical, automotive, industry, aeronautics, spatial and defense markets.

The platform has 20 ongoing strategic partnerships with components and systems manufacturers and end users. Its activities cover the entire component-development chain, from simulation, design, and technology development to demonstrator systems and industrial scale-up. Other activities include advanced morphological and electrical characterization and reliability studies.

Nanocharacterization Platform

Characterization of advanced materials and components supporting disruptive innovation

Main Activities

- Magnetic resonance
- Scanning probe microscopy
- Ion beam analysis
- Surface analysis
- Optics & X-rays analysis
- Electron microscopy
- Sample preparation
- Digital data processing

Key figures

- 3,600 m² of equipment
- 100 research engineers
- 90 publications a year
- €35M of cumulated investments

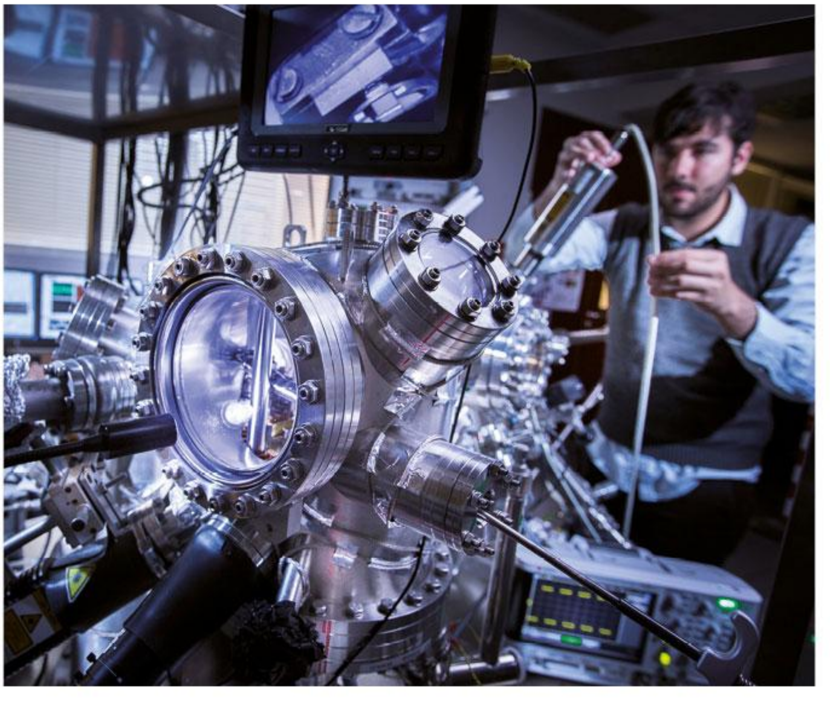
CEA-Leti's teams support the innovation needs of industrial partners throughout all development stages via bilateral contracts and shared laboratories. The platform works with more than a dozen partners, such as: SERMA Technologies, Physical Electronics (ULVAC-PHI) and Attolight.

The nano-characterization platform offers an access to over 100 researchers that operate state-of-the-art equipment and analyse properties of innovative materials and components.

With more than 50 world-class equipment, researchers supports companies of all sizes, from startups to major groups. They provide in-depth analysis, investigating new materials and components properties—morphological, physical, chemical, and electrical behaviors. They also collaborate with nanocharacterization tools suppliers to improve their equipment performance.

To be more specific, our researchers characterize advanced materials, complex stacks, new devices and manufacturing processes using customized analysis and characterization protocols. They also leverage large scale infrastructures, partnering with ESRF and ILL, as well as other key academic partners.

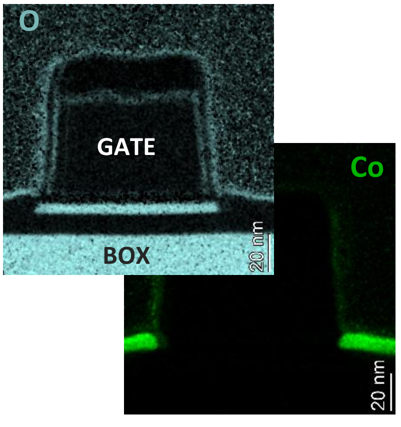
They also provide results and interpretations, such as atomic-scale 2D mapping, multi-scale 3D reconstructions, multi-scale composition analysis (from µm down to sub-nm), crystallographic structures, optical properties, and surface compositions.



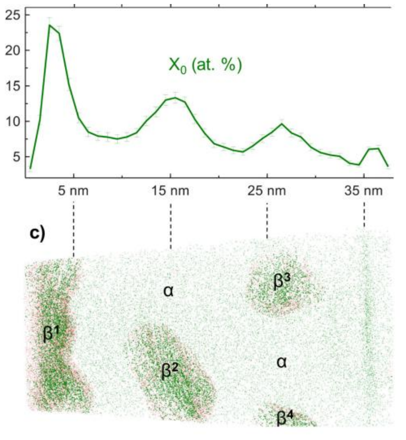
Materials and processes

SL-DRT-26-0545

Superconducting silicide contacts on hyperdoped silicon by nanosecond pulsed-laser annealing



TEM images of a superconducting FD-SOI $CoSi_2$ transistor



Atom Probe Tomography analysis of boron-hyperdoped silicon

Context :

In the race towards building a quantum computer, there is a deep interest in fabricating devices based on the robust and scalable silicon FD-SOI technology. One example is the Josephson Field Effect Transistor (JoFET) whose operability relies on the high transparency of the interface between the superconducting source/drain regions and the semiconducting channel. Such transparency could be improved by doping the source/drain regions, and hence lowering the Schottky barrier height at the superconductor/semiconductor interfaces.

This PhD aims at developing highly transparent superconducting silicide contacts on a 300 mm production line using Nanosecond Pulsed Laser Annealing (NPLA). NPLA will play a key role for reaching extremely high doping concentrations in silicon [1,2], then forming the superconducting silicides ($CoSi_2$, V_3Si) with minimal thermal budget and related dopant deactivation. A particular focus will be devoted on the stresses during silicide formation and their impact on the superconducting critical temperature. Also, the distribution of dopants will be assessed by Atom Probe Tomography (APT), an advanced 3D imaging technique capable of imaging the distribution of dopants at the atomic scale [3]. Finally, electrical measurements on fabricated junctions and transistors will be carried out at low temperature (< 1 K) in order to evaluate the transparency of the superconducting contacts.

Required skills :

The candidate must hold a Master's degree in Physics, Nanoscience and nanotechnology, Material Science or Electrical engineering. She/he have to be autonomous, a high team spirit and likes interacting with experts and engineers.

 # Silicon technology
 # Quantum
 # Superconductivity
 # Laser annealing
 # Strain
 # Atom Probe

Application & societal impact

- Strengthening European collaboration and sovereignty in quantum technology development

Further info

- PHD position
- REF :

[1] N.Chery et al. Journal of Applied Physics 131.6 (2022)

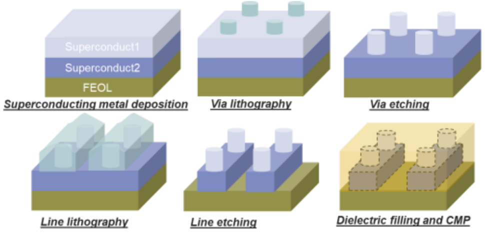
[2] P.Dumas et al. *Applied Physics Letters* 123.13 (2023).

[3] Duguay, S., et al Journal of Applied Physics 108.3 (2010).

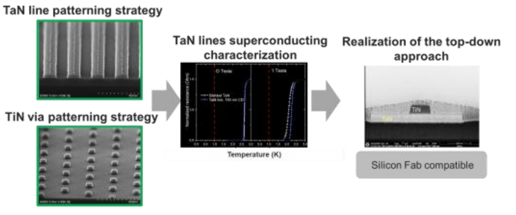
To apply, please contact:
paul.dumas@cea.fr

OFFER'S REFERENCE

Superconducting BEOL integration for upcoming quantum devices



Sketch of the process flow [1]



Advanced clean room characterizations [1]

Context :

Controlling and manipulating quantum information using advanced nanoelectronic technologies represents a major challenge currently undertaken by CEA-LETI and its partners. A key objective of this project is to achieve the integration of quantum devices within Fully Depleted Silicon-On-Insulator (FD-SOI) technology on a 300 mm platform. The success of this integration critically depends on the development of superconducting interconnects, which are essential for ensuring the thermomagnetic isolation of quantum devices in addition to ensuring the electrical continuity of the device.

The proposed integration scheme builds on a CEA-LETI patent that enabled the fabrication of TaN/TiN-based superconducting interconnections, exhibiting a critical temperature (Tc) on the order of one kelvin [1]. The goal of this research project is to explore the integration of superconducting materials with higher critical temperatures (around ten Kelvins) in order to enhance thermomagnetic isolation and improve overall device performance. This postdoctoral project aims to investigate the potential of newly developed high-temperature superconducting materials — such as ZrN, HfN, and NbTiN — produced by ICPMS-CNT and CEA-LETI, as well as their integration into the existing process flow. Using an innovative direct etch approach, the postdoc will study the impact of the process step on the superconducting properties. The influence of line dimensions on the superconducting properties such as critical temperature and current density of the materials will be also investigated. Based on the results obtained, process and integration adjustments will be proposed to optimize performances.

The postdoc will carry out structural and morphological characterizations (X-ray diffraction, TOF-SIMS, AFM, and microscopy) of the selected superconducting materials. In the second phase, she or he will work on integrating these materials in the fabrication of interconnexion lines and vias in CEA-LETI 300 mm cleanroom[1]. Once fabrication is complete, measurements of the critical temperature and magnetic field will be performed on the superconducting lines using a cryostat outside the cleanroom.

Required skills :

Looking for a PhD holder with experience in nanofabrication processes, including etching, material integration, and nanoelectronic device technologies. She/he have to be autonomous, a high team spirit and likes interacting with expert and engineers.

 # Nanoelectronics
 # Quantum
 # Superconductivity
 # Back end of line
 # Material characterization

Application & societal impact

- Strengthening European collaboration and sovereignty in quantum technology development

Further info

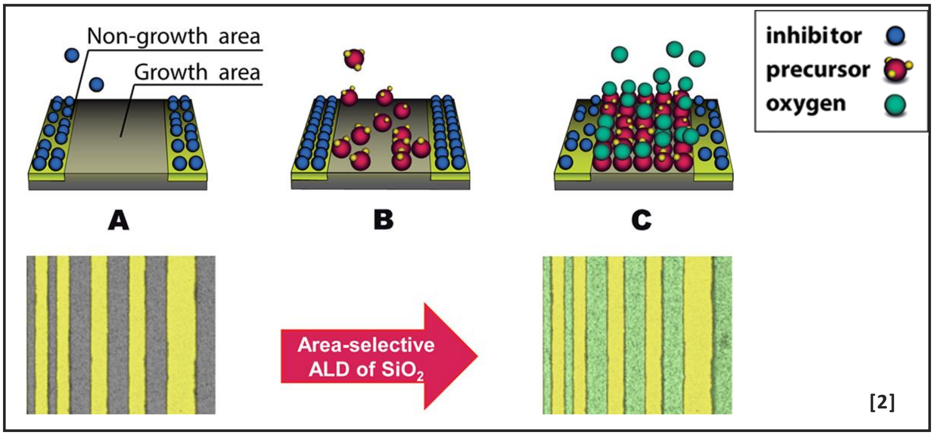
- Post-Doc position
- Multilateral collaboration
- REF :

[1] T.Chene et al, J. Vac. Sci. Technol. B 43, 022216 (2025)

To apply, please contact:
paul.dumas@cea.fr

SL-DRT-26-0541

Selective Oxide Deposition by ALD



 # Microelectronics
 # Thin-film material
 # ALD
 # ASD, Selectivity
 # Nanocharacterization

Context :

For next-generation microelectronics, **Area Selective Deposition (ASD)** [1] is a promising approach to simplify integration schemes for the most advanced technology nodes. These ASD approaches need to be adapted according to a **trio** comprising the material to be deposited, the growth surface, and the inhibited surface.

This PhD focuses on the area selective deposition of oxides (such as **SiO_2, Al_2O_3, ...**) on **Si** or SiO_2 and not on silicon nitride (**SiN**) [2], which is one of the most complex topics in ASD, and aims to evaluate the relevance of this type of process for **simplifying the integration and the fabrication of advanced FDSOI transistors** [3].

To develop this selective oxide deposition process, various approaches aiming at making SiN an inhibitor of the **Atomic Layer Deposition** (ALD) will be explored (plasma treatments, Small Molecular Inhibitors, combination of both, etc). Dedicated surface characterizations will be carried out in order to better understand the mechanisms of inhibition at the origin of the selective deposition and allowing to achieve high selectivity for oxide thicknesses of 10 nm and above.

This PhD project will take place at **CEA-LETI**, within the advanced materials deposition department, in collaboration with **LMI UMR 5615 CNRS/UCBLyon**. The student will have access to the CEA-LETI 300 mm **cleanroom fabrication platforms** for **thin film** deposition by PEALD, the CEA **nanocharacterization** platform and **gas-phase surface functionalization set-up** at LMI. Surface analyses and thin film characterizations (ellipsometry, XRR, AFM, FTIR, contact angle, SEM, XPS, ToF-SIMS) will be used to determine the best selectivity and understand the physico-chemical mechanisms.

Required skills: B+5 (M2 or **engineer)** in **Materials Science** / **Physics – Chemistry**. / Microelectronics

Application & societal impact

- Microelectronics of the future towards eco-design with material creation only in the required areas, avoiding full deposition followed by partial etching

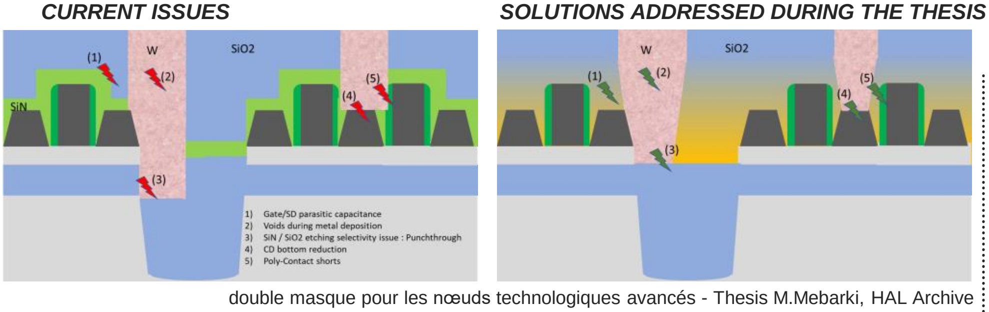
Further info

- [1]https://pubs.acs.org/doi/10.1021/acs.chemmater.0c00722
- [2]https://pubs.acs.org/doi/10.1021/acsnano.7b04701
- [3]https://www.youtube.com/watch?v=jDhLOqoIgAk

To apply, please contact:
chloe.guerin@cea.fr
vincent.jousseaume@cea.fr

SL-DRT-26-0536

Introduction of innovative materials for sub-10nm contact realization



double masque pour les nœuds technologiques avancés - Thesis M.Mebarki, HAL Archive

Context: As part of the FAMES project and the European ChipACT initiative, which aim to ensure France's and Europe's sovereignty and competitiveness in the field of electronic nano-components, CEA-LETI has launched the design of new FD-SOI chips. Among the various modules being developed, the fabrication of electrical contacts is one of the most critical modules in the success of advanced node development.

Challenges: For sub-10 nm node, the contact realization is facing a lot of challenges like punchthrough (due to low etch selectivity during contact etching), voids during metal deposition, self-alignment, and parasitic capacitance (as summarized on the top left picture). New breakthrough approach has recently been proposed (Patent FR2507558) consisting in the deposition of new dielectric films with chemical gradient. This thesis focuses on the development (deposition an etching processes) of new gradient compounds incorporated into SiO_2 to address the current issues.

Goals: Supervised by a dynamic team with multidisciplinary expertise, the PhD candidate will develop technical and scientific skills. Most part of the work will be in the CEA-LETI cleanrooms, where the PhD candidate will first perform depositions on blanket wafer of new SiO_2 films with different gradient using a 300 mm PECVD tool. Physico-chemical characterizations (using ellipsometry, XPS, TOFSIMS, FTIR, stress, defectivity…) of the different compounds incorporated into SiO_2 deposited layers will be performed by the student in collaboration with LETI's nanocaracterization platform. Then the candidate will carry out the etching of these films in a 300mm RIE tool. Etch mechanism of these new films will be understood using the different complementary characterization technics detailed above. Finally, the student will evaluate on patterned wafers the impact of these films on the etch profile using SEM analyses. Based on the profile and selectivity requirements, the best film will be electrically tested to assess its benefits on functional designs.

Required Skills: This thesis is open to candidates with a Master's or engineering's degree in physics/materials science and/or chemistry. The candidate should present a strong interest in research and has to be able to work in autonomy.

 # microelectronics
 # etching
 # deposition
 # integration
 # caracterisation

Application & societal impact

- Contact realization for advanced nodes using innovative dielectric film

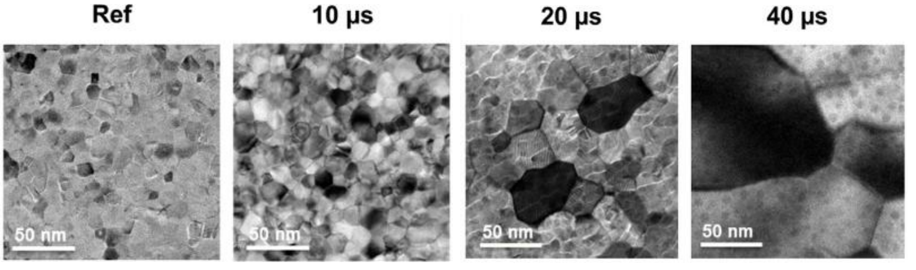
Further info

- Etude de la gravure des contacts en présence d'un double masque pour les nœuds technologiques avancés - Thesis M.Mebarki, HAL Archive
- «Procédé de structuration d'un empilement comprenant une couche d'oxycarbure de silicium avec gradient de carbone », N.Posseme et al, Brevet FR2507558

To apply, please contact:

nicolas.posseme@cea.fr
pierre.brianceau@cea.fr
jean-pierre.nieto@cea.fr
emmanuel.petitprez@cea.fr

Towards the Improvement of the conductivity of Metal Lines for Advanced Nodes



Example of Ruthenium grain growth after microsecond laser annealing for enhanced conductivity [Daubriac, 2025].

Context :

Improving the conductivity of metal interconnect lines helps to reduce energy losses (Joule effect), enhance signal propagation, limit the risk of electromigration, and, last but not least, ensure compatibility with device miniaturization (advanced FDSOI or 3D integration). This PhD aims to investigate the effect of various short laser annealing processes (including millisecond, microsecond and nanosecond) on the resistivity of metal lines. The first objective is to study the evolution of grain size during various laser annealings of blanket-deposited copper, tungsten and cobalt films. Various metal thicknesses as well as several barrier layers will be leveraged. The formed layers will be characterized using scanning electron microscopy, four-point probe resistance measurements, Haze measurements, and atomic force microscopy. More advanced characterizations will also be occasionally employed, such as transmission electron microscopy, electron backscatter diffraction analysis, and X-ray diffraction. Finally, test vehicles will be used to study the effect on patterned wafers (line resistivity). The PhD will last three years and this research work will take place in the cleanrooms of LETI (CEA Grenoble site).

Required skills :

The candidate is an engineering student or Master's level (M2) with a background in materials for microelectronics. A candidate with a strong motivation to work in an R&D environment, in a cleanroom will be preferred. Skills in characterization techniques, such as Scanning Electron Microscopy and four-point probe resistance measurements, will be appreciated.

 # Microelectronics
 # Materials
 # Characterizations
 # Metallic lines

Application & societal impact

- These developments are part of the FAMES project, which aims to develop more energy-efficient chips.

Further info

- Review : "Selecting alternative metals for advanced interconnects, Soulié et al., J. Appl. Phys., 2024.
- Overview of Ruthenium Thin Films Annealed by Microsecond Scanning UV Pulsed Laser Daubriac et al., Adv. Eng. Mater. 2025, 27.

To apply, please contact:
mathieu.opprecht@cea.fr

SL-DRT-26-0509

An electrochemical flow microreactor for a greener synthesis of gold nanoparticles

 # microelectronics
 # nanoparticles
 # electrochemistry
 # photonics
 # biosensors

Context :

Gold nanoparticles (AuNPs) possess unique electronic, photonic, and chemical properties of invaluable interest in a variety of medical and technological applications. They are typically produced by controlled chemical precipitation from a salt solution to achieve the precise size control critical for most applications. Continuous flow microreactors, which efficiently mix the salt solution and the reducing agent, are known to offer improved size control. However, even in these reactors, the smallest AuNPs can only be formed using powerful reducing agents that are harmful to human health or the environment. We propose to minimize their impact by inserting an electrochemical cell into the reactor to form the reducing agent *in-situ* in the adjusted amount necessary to produce the desired AuNPs.

Your goal will be to test and adapt continuous-flow electrochemical cells for the synthesis of AuNPs, exploring various electrochemical reactions and cell designs. A careful examination of AuNPs characteristics (size, interfacial and optical properties, etc.) will guide you in this research.

Required skills :

You hold a master's degree in (electro)chemistry and/or materials science, are rigorous, curious, and eager to thrive in a rich and stimulating scientific environment. Do not hesitate to apply!

Application & societal impact

- AuNPs are used in biosensors, as they can be detected *in vivo* owing to their tunable photoluminescence.
- They can also be used as radio-sensitizers or even as therapeutic delivery systems.

Further info

- L. Panariello *et al., React. Chem. Eng.* **5**(4), 663, 2020
- V. V. Yanilkin *et al., Russ. Chem. Rev.* **87**(11), 1080, 2018
- A. Montero-Oleas *et al., ACS Appl. Nano Mater.*, **8**(7), 3631, 2025
- T. Noël *et al., Acc. Chem. Res.* **52**(10), 2858, 2019

To apply, please contact:
paul.haumesser@cea.fr

SL-DRT-26-0420

Advanced electrode materials by ALD for ionic devices

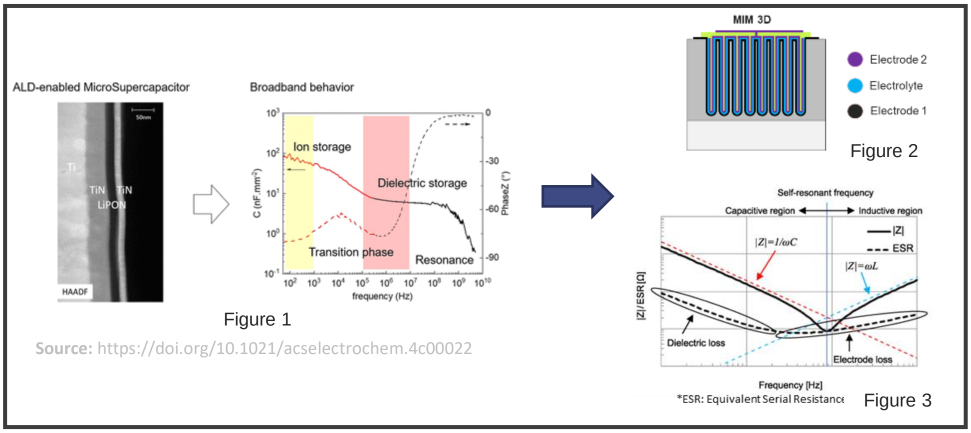


Figure 1 Figure 2 Figure 3

Source: https://doi.org/10.1021/acselectrochem.4c00022

Microelectronics
Ultrathin and ultraconformal materials
Atomic Layer Deposition
Supercapacitances
Ionic materials

Context:

Ionic-based 3D supercapcitances are the most promising ways to fulfil the requirement of energy storage component for microelectronic applications (automotive and IoT). In this context, CEA-LETI has a special focus on 2D (Figure 1) as well as on 3D (Figure 2) configurations for ionic devices. One interest concerns the use ultra conformal deposition technique (ALD for Atomic Layer Deposition) of lithium-based layers for electrolyte and highly conductive layers for electrodes. The material functionality are highly related to material nature, thickness and substrate (planar vs 3D). In addition, the ESR criteria of fabricated capacitances (Figure 3) are electrode-dependant at high frequency range for PDN application (Power Distribution Network).

In this regard and based on the CEA-Leti tool sets, the proposed PhD project aims to evaluate ALD technique for the developments of material solutions including interface engineering for electrodes use (ultrathin films <10nm, high aspect ratio structures >30, high conductive layers resistivity <200µΩ.cm).

The ALD electrode material nucleation (including noble metal and metal nitrides) will be evaluated on 2D planar and 3D complex substrates, with and without ionic layers, in order to improve electrode performances and stability. Physical and chemical properties will be studied with SEM, EDX, XPS, XRR and XRD. Electrical performances will be studied using dedicated nanovias Kelvin structures. The optimized electrode material solutions will be implemented into functional MIM capacitance vehicle tests and electrochemically-characterized (impedance spectroscopy, cycling) in order to evaluate the potential of this electrode solutions.

Profile: Master degree: Materials/Microelectronics

Application & societal impact

- Energy storage materials and components for microelectronic

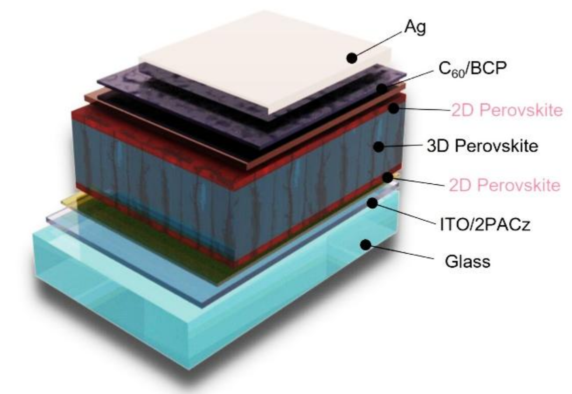
Further info

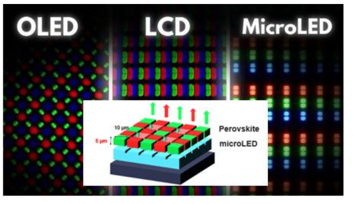
- 10.1021/acselectrochem.4c00022
- https://doi.org/10.1021/acs.chemmater.9b00675
- https://doi.org/10.1002/smtd.202402166

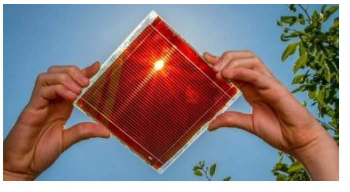
To apply, please contact:
messaoud.bedjaoui@cea.fr

SL-DRT-26-0569

Growth of 2D/3D perovskites by PLD for optoelectronics and solar cells







Source: https://doi.org/10.1038/s41586-024-07189-3

Context:

Halide perovskites are extremely promising materials in the fields of optoelectronics and solar PV. They have exceptional optoelectronic properties, such as a direct bandgap, a high absorption, and very high quantum yields. It is possible to produce them at low cost compared to classical semiconductors. For solar PV, they could be a way to increase solar cell power efficiency while decreasing production costs. This is a very promising way to make to clean and abundant energy even more accessible. For optoelectronics, they could enable the production of displays with a very high resolution and a high power efficiency, which could enable the design of augmented reality glasses. The challenge for halide perovskites is to fabricate them at large scale while increasing their stability.

CEA-Leti develops an inorganic halide perovskite fabrication process using Pulsed Laser Deposition (PLD). CEA has access to a unique PLD reactor and has already demonstrated large-scale perovskite fabrication for materials such as $CsPbBr_3$ and $CsPbI_3$. The goal of this PhD is to improve this process using a new bidimensional (2D) perovskite and 2D/3D perovskite heterostructure, in order to improve perovskite quality and stability. The fabrication of these 2D perovskites by PLD will be a first important step of the PhD. Physical and chemical properties will be studied with SEM, XPS and XRD, among others. Electro-optical performances will be studied using photoluminescence and stability measurements. The new materials will be integrated into functional solar cells and LEDs in order to evaluate the potential of this technology and to optimize its fabrication process.

Profile: M.Sc or École d'ingénieur in Materials or Physics

#Perovskites
#microLEDs
#Solar PV
#PLD

Application & societal impact

- Renewable energy
- Microdisplays for augmented reality

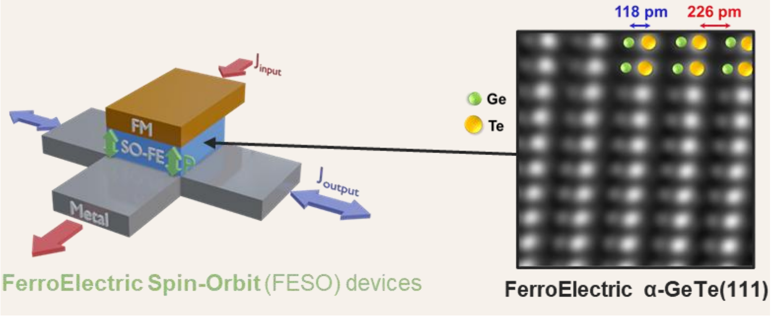
Further info

- https://onlinelibrary.wiley.com/doi/abs/10.1002/sdtp.17471
- https://www.nature.com/articles/s41586-024-07189-3

To apply, please contact:
Florian.dupont@cea.fr

SL-DRT-26-0409

Growth of thin films of 2D topological insulating and ferroelectric chalcogenide materials for low-power electronics



Context :

The energy consumption of the electronic devices that have invaded our lives is becoming critical given the major issues of climate change and the European and global geopolitical context. That is why we must now drastically reduce the consumption of all these devices that surround us by developing disruptive technologies that require very low energy consumption and sustainable energy sources. Chalcogenide materials, particularly Ge-Sb-Te (GST) alloys, are essential for phase-change memories (PCMs). Although high-performing, these memories consume a lot of energy, prompting the search for alternative solutions. GST alloys offer unique opportunities in the field of spin-orbitronics. Among these, 2D topological insulator (TI) GST alloys and ferroelectric Rashba semiconductors (FERSC) offer promising avenues for new types of more efficient memories. The aim of this thesis is to develop and master the industrial-scale vdW growth of FERSC films based on the α-GeTe(111) alloy and pseudo-2D layers of TIs based on Sb_2Te_3 alloys with a view to producing FESO and SOT-MRAM demonstrators.

Over the past few years, at LETI we have developed unique, patented expertise in the growth of Te- and Se-based chalcogenide films by van der Waals epitaxy using the industrial magnetron co-sputtering deposition technique. For his phD project, the doctoral student will have access to Leti's clean rooms for the growth of thin films (200/300 mm industrial co-sputtering equipements) and their basic characterization (Raman, ellipsometry, XRD, XRR, WDXRF, resistivity, etc.). To determine ferroelectric properties and spin-charge interconversion in TI layers, the student will have access to advanced characterization methods such as Transmission Electron Microscopy imaging, piezoelectric force microscopy (PFM), synchrotron radiation facilities through beam time requests at ESRF and SOLEIL (XRD and anomalous diffraction, XAS, etc.) or time-resolved stimulated ARPES (Angle-Resolved Photo-Electron Spectroscopy) at CELIA in Bordeaux for the topological insulator aspect. The materials will be also evaluated in demonstrators in collaboration with the SPINTEC laboratory and the start-up Nellow.

Required skills : Master in Physics or Materials Science or Microelectronics

microelectronics
Low-power
Chalcogenide
Thin Films
Spintronics

Application & societal impact

- Frugal electronics
- Exploiting ferroelectric properties and topological insulators

Further info

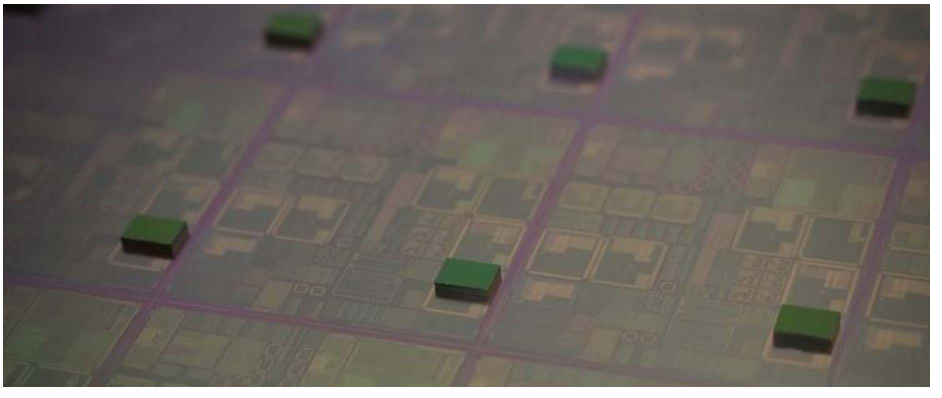
- D. Térébénec, et al., "GeTe/Sb2Te3 Super-Lattices: Impact of Atomic Structure on the RESET Current of Phase-Change Memory Devices," Advanced Electronic Materials **11**(2), 2400290 (2025).
- P. Noé, et al., "Phase-Change and Ovonic Materials (Sixth Edition)," Physica Status Solidi (RRL) – Rapid Research Letters **19**(7), 2500218 (2025).
- V. Sever, et al., "Quantitative Scanning Transmission Electron Microscopy–High-Angle-Annular Dark-Field Study of the Structure of Pseudo-2D Sb2Te3 Films Grown by (Quasi) Van der Waals Epitaxy," Physica Status Solidi (RRL) – Rapid Research Letters **18**(10), 2300402 (2024).
- S. Teresiet al., "Spin-Orbit Readout Using Thin Films of Topological Insulator Sb2Te3 Deposited by Industrial Magnetron Sputtering," Advanced Functional Materials **33**(44), 2303878 (2023).

To apply, please contact:

Pierre.noe@cea.fr

SL-DRT-26-0571

Dies to wafer direct bonding: from physical mechanisms to the development of thin stackable dies



 # microelectronics
 # Dies to wafer
 # Direct bonding
 # 3D integration

Context :

Direct dies-to-wafer bonding has become, in recent years, a major development axis in microelectronics and at the heart of many LETI projects, both in silicon photonics and for 3D applications involving hybrid bonding.

Due to their small size, die bonding allows the study of direct bonding edge effects and the implementation of new direct bonding processes that can shed original light on the mechanisms of direct bonding, which are already well studied at LETI. From a more technological perspective, the development of thin stackable chips will also be a very interesting technological key for many applications.

As a doctoral student at the CEA, you will have the opportunity to work in a world-renowned research environment. Our teams are made up of passionate and dedicated experts, offering a framework conducive to learning and collaboration. You will have access to state-of-the-art equipment and first-rate research resources to carry out your assignments.

Daytime work in the LETI clean room as part of the surface and interface team.

Required skills :

You are passionate about scientific and technological research and are recognised for your taste for experimental work and your interpersonal skills. You have knowledge of materials, chemistry and surface treatment.

Application & societal impact

- 3D integration
- Silicon photonics

Further info

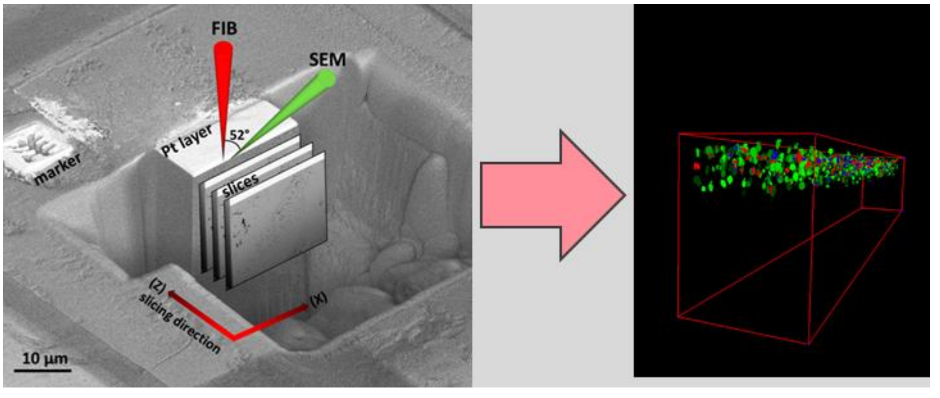
- https://www.youtube.com/watch?v=ky0-JlfuuM8, **Discover: die-to-wafer hybrid bonding | CEA-Leti**
- **https://chipscalereview.com/wp-content/uploads/2022/09/ChipScale_Sep-Oct_2022-digital.pdf**

To apply, please contact:
loïc.sanchez@cea.fr

Photonics

SL-DRT-26-0517

Advanced Defect Characterization for High-Performance Infrared Detectors



Context:

The Leti Infrared Laboratory is offering a three-year PhD position. Located in Grenoble, this laboratory has been internationally recognized since the 1980s for its specialization in designing and manufacturing infrared camera prototypes used in defense, astronomy, environmental monitoring, and weather satellites.

In this context of high-performance imaging, it is crucial to ensure optimal detector quality. However, manufacturing processes can introduce defects that can degrade sensor performance.

The objective of the thesis is to identify and precisely characterize these defects using cutting-edge techniques, such as synchrotron-based Laue microdiffraction and FIB-SEM nanotomography, enabling structural analysis at different scales. By linking the nature and origin of defects to manufacturing processes and quantifying their impact on performance, the student will contribute directly to improving the reliability and efficiency of next-generation infrared sensors.

The student will join a team covering the entire detector manufacturing chain and will actively participate in the development (Leti clean room) and structural characterization of samples.

Required skills:

Master's student, specializing in materials science and/or semiconductor physics

 # Infrared Detectors
 # Material science
 # Residual Defects
 # Electron Microscopy
 # Detector performance

Application & societal impact

- Improvement of very high-performance infrared detectors used for environmental and climate monitoring

Further info

- Nano-tomography:

https://www.mem-lab.fr/en/Pages/LEMMA/Battery.aspx:

- Infrared imaging:

Vision infrarouge : des images d'une netteté exceptionnelle

To apply, please contact:

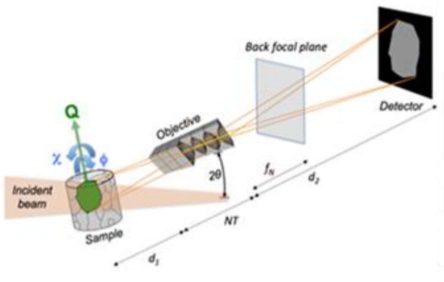
clement.Lobre@cea.fr

Characterization

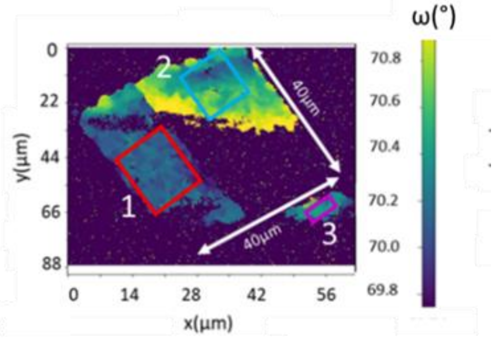
Job offers / **PhDs**

SL-DRT-26-0523

Sharper Structural Insight in Nanoelectronics with Dark-Field X-Ray Microscopy



DFXM setup at ID03@ESRF



GaN mosaicity investigated by DFXM

J. Appl. Cryst. (2023). 56, 643–649

Context

Dark-field X-ray microscopy (DFXM) is an emerging, non-destructive synchrotron technique capable of imaging strain and crystalline defects with 30–100 nm resolution over large fields of view. Recent upgrades at the ESRF and the ID03 beamline have increased X-ray intensity by two orders of magnitude, enabling investigation of the most challenging nanoscale structures produced in cleanroom environments. This PhD aims to exploit DFXM for the analysis of advanced microelectronic architectures subjected to critical thermo-mechanical stress. DFXM will provide 3D mapping of strain, orientation and buried defects in complex devices without sample destruction. A comparative study will be performed against complementary local X-ray techniques such as Laue microdiffraction and scanning X-ray diffraction microscopy. Multi-scale correlations will be established with TEM and Raman spectroscopy. Finite-element simulations will support interpretation by modelling the mechanical behaviour under thermal or operational loads. The objective is to define a robust methodology for multiscale strain analysis in microelectronics. This work will contribute to improved reliability and design optimization of next-generation devices.

This PhD will take place at the Nanocharacterization platform of the CEA–LETI and is embedded in a strong ESRF@ID03 collaboration and supports advances in quantum technologies, photonics and energy-efficient microelectronics.

Required skills A Master’s degree in physics, materials science, or light–matter interaction; solid competence in Python and a strong interest in data analysis; ability to critically assess experimental and numerical results; strong motivation to work in a multidisciplinary environment; excellent command of written and spoken English.

 # Nanoelectronics
 # Nanocharacterization
 # X-ray nanodiffraction
 # Large-scale facilities
 # Synchrotron

Application & societal impact

- Reliability of nano devices applied to quantum technologies, advanced photonics and energy-efficient microelectronics.

Further info

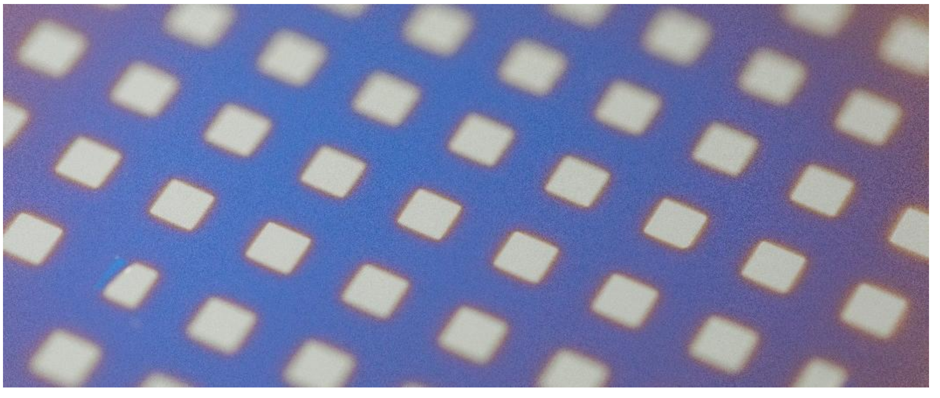
- *Acta Materialia 220 (2021) 117290*
- *J. Appl. Cryst. (2023). 56, 643–649* 071-7
- *https://www.esrf.fr/home/UsersAndScience/Experiments/StructMaterials/id03-hard-x-ray-microscopy.html*0.1039/d1fd00110h

To apply, please contact:

patrice.gergaud@cea.fr
can.yildirim@esrf.fr

SL-DRT-26-0560

Next-Gen Surface Analysis for Ultrathin Functional Materials



Context

Advanced nanoelectronics and quantum devices rely on ultrathin oxides and engineered interfaces whose chemical composition, stoichiometry and thickness must be controlled with sub-nanometer precision. LETI is installing **the first 300-mm multi-energy XPS–HAXPES tool with angle-resolved capability**, enabling ***quasi in situ* chemical metrology** from deposition to characterization.

This PhD will develop **quantitative, multi-energy and angle-resolved XPS/HAXPES methodologies** for ultrathin oxides and oxynitrides, validate measurement accuracy, and establish robust protocols for ***quasi in situ* transfer** of sensitive layers. Applications include advanced CMOS stacks and **quantum Josephson junctions**, where sub-2 nm AlO_x barriers critically determine device performance.

The project directly supports the development of next-generation quantum technologies, advanced photonics and energy-efficient microelectronics by improving the reliability and stability of nanoscale materials. The work will be carried out within a strong multi-partner framework.

Required skills

Master's degree in materials science, physics, or physical chemistry; strong interest in surface analysis, thin films, and data analysis; ability to work in a multidisciplinary environment.

 # Microelectronics
 # Functional Materials
 # Quantum devices
 # Nanocharacterization
 # X-ray photoemission

Application & societal impact

- Reliable ultrathin-film metrology accelerates quantum technologies, advanced photonics and energy-efficient microelectronics.

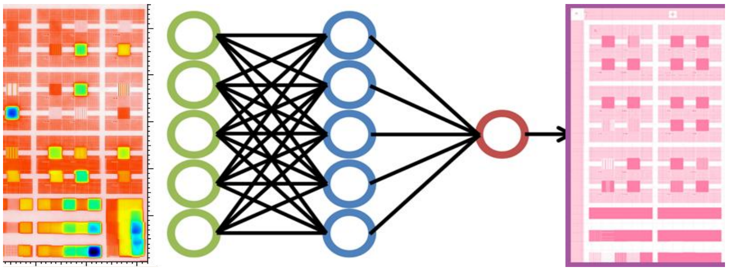
Further info

- https://doi.org/10.1088/1361-6528/ac5f2e
- https://doi.org/10.1038/s41598-024-74071-7
- https://doi.org/10.1038/s41534-024-00840-x
- https://doi.org/10.1039/d1fd00110h

To apply, please contact:
emmanuel.nolot@cea.fr

SL-DRT-26-0469

Artificial Intelligence for the Modeling and Topographic Analysis of Electronic Chips



Context :

The fabrication of modern semiconductor devices relies on precise control of surface topography at nanometer scales. Process variations during deposition, etching, and chemical-mechanical planarization (CMP) can introduce critical topographical defects such as dishing, erosion, and lithographic defocus, directly impacting device yield and reliability. Recent advances in deep learning, particularly convolutional neural networks (CNNs) and vision transformers, have demonstrated exceptional capability in high-dimensional pattern recognition and spatial prediction tasks. These AI-driven approaches allow to enhance defect detection and topography prediction in semiconductor manufacturing. However, significant challenges remain in developing models that are both computationally efficient and robust enough for industrial deployment.
This PhD project is dedicated to advanced wafer surface topography characterization through the development and validation of innovative deep learning architectures based on optical interferometry data. A primary focus of the research will be the creation of advanced neural network models adapted for semiconductor surface topography prediction based on interferometric measurements. The study will also emphasize the design of advanced topographical defect detection and classification algorithms able to identify critical process anomalies.

The PhD candidate will conduct research in collaboration with CEA-Leti, a world-leading research institution in microelectronics, providing access to state-of-the-art semiconductor fabrication facilities and high-performance computing resources.

Required Skills:

A Master's degree (engineering school or university) in Computer Science, Applied Physics, or a related field. The candidate must have strong programming skills in Python, deep learning, and image analysis. The candidate must also be able to work autonomously and collaborate effectively with a research team.

 # microelectronics
 # AI
 # Neural Networks
 # Image Analysis
 # Optical Interferometry

Application & societal impact

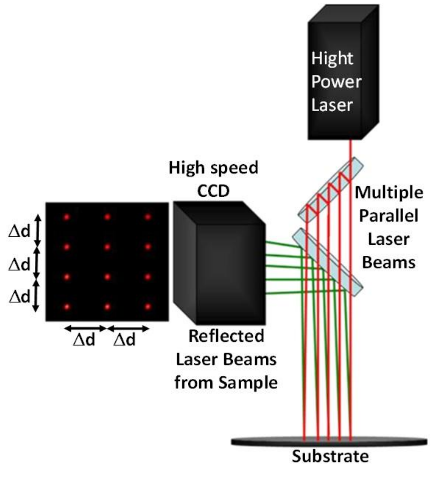
- Improving microfabrication processes, thereby reducing costs and increasing the efficiency of electronic chips production.

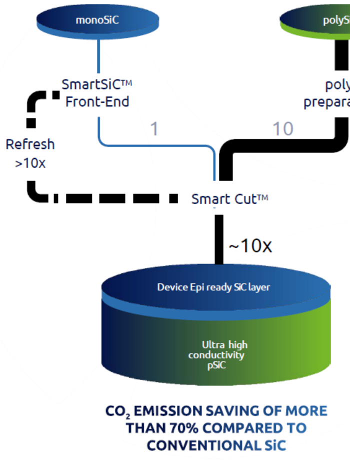
Further info

- A Fine-Grained, End-to-End Feature-Scale CMP Modeling Paradigm Based on Fully Convolutional Neural Networks
- DOI:10.1109/TSM.2023.3264255

To apply, please contact:
viorel.balan@cea.fr

In-situ Experimental Analysis and Non-Linear Modeling of Thermomechanical Deformations in Engineered Substrates





 # microelectronics
 # stress
 # heterostructure
 # simulation
 # experimental

Context :

For industrial partners, controlling deformations and stresses in heterostructures is critical. Current methods (experimental measurements, FEM/analytical simulations) are limited, especially for temperature-dependent deformations, often reduced to room-temperature measurements (bow/warp), which fail to capture non-linear and anisotropic effects in advanced substrates.
This thesis aims to:
- Use experimental tools (optical reflectometry/confocal microscopy) to measure local and global deformations, including large deformations and bifurcation phenomena at high stress thresholds.
- Develop simulation tools (Python + COMSOL) for heterostructures, addressing non-uniform layers, deposition patterns, intrinsic variability, and anisotropy.
- Indirectly characterize temperature-dependent mechanical properties via "double curvature measurement," extending its application to heterostructures.
- Assess the impact of manufacturing processes on total deformation by measuring substrates before/after each step, integrating thermal evolution and non-linear effects.

Required skills :

Master's degree (engineering school or university). Strong interest in materials mechanics, experimental techniques, and numerica simulation tools. Collaborate with industrial partners to develop new fabrication conditions.

Application & societal impact

- 3D Integration, POI, SmartSiC, Vertical Transistors
- Thermomechanical simulations considering anisotropy and large deformations

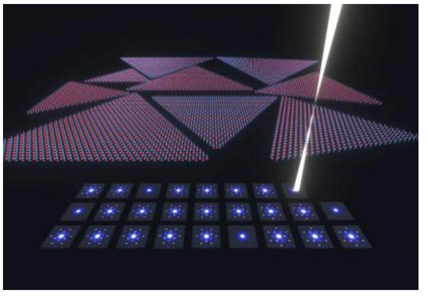
Further info

- https://www.pepr-electronique.fr/projet_cible_vertigo/
- DOI:10.1109/EuroSimE56861.2023.10100763
- DOI:10.1109/TSM.2024.3410513

To apply, please contact:
lionel.vignoud@cea.fr

SL-DRT-26-0494

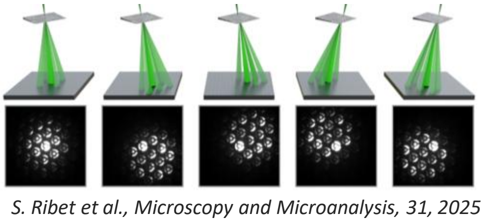
PhD in transmission electron microscopy: development of multi-angle 4D-STEM imaging



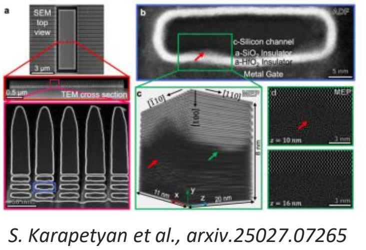
Context: The Platform for Nano-characterization (PFNC) at CEA Grenoble is equipped with a large suite of state-of-the-art equipment for physio-chemical characterization in micro- and nano-technology, nano-materials, materials for energy research, and in the life sciences. At the PFNC, the transmission electron microscopy (TEM) laboratory develops and masters innovative imaging techniques, in order to expand the capabilities of its instruments.

Project: Multi-angle 4D-STEM imaging is a recently developed TEM technique that involves the sequential acquisition of diffraction pattern datasets with the electron beam at different tilt angles. Closely related to Precession Electron Diffraction, this approach provides access to additional angular information that can be exploited to enhance spatial resolution, improve strain-mapping precision, and increase the robustness of phase and orientation mapping. The PhD project will be structured in two main phases. The first phase will focus on establishing an optimal acquisition protocol and developing data-processing strategies to merge the different datasets. The objective is to build a versatile, user-friendly discretized precession tool capable of state-of-the-art performance for measuring nanoscale material properties. The second phase, which will be more exploratory in nature, will align with the long-term goal of achieving routine three-dimensional nano-characterization. Recent studies have demonstrated small-tilt-angle ptycho-tomography for 3D reconstruction using 4D-STEM on semiconductor devices, with acquisition schemes similar to those that will be investigated in this thesis. These methods represent the state of the art both experimentally and computationally, and require a deep understanding of experimental conditions, wave–matter interactions, and numerical reconstruction techniques. Exploring and optimizing tilted acquisitions to improve precession diffraction are the first steps towards future ptycho-tomography developments at the PFNC, which the feasibility of which the student will explore.

Required skills: PhD for a motivated candidate interested in instrumentation and numerical simulation, with good knowledge of solid-state physics. The project, both hardware and simulation-based, will require strong critical-thinking skills and ability to summarize complex results. Good Python programming skills will be appreciated.



S. Ribet et al., Microscopy and Microanalysis, 31, 2025



S. Karapetyan et al., arxiv.25027.07265

 # microelectronics
 # electron microscopy
 # instrumentation
 # simulation
 # Python

Application & societal impact

- Development of advanced characterization techniques to support innovation in microelectronics

Further info

- S.M. Ribet et al., ArXiv: 2506.11327
- D. Cooper et al., Micron 80 (2016) 145

To apply, please contact:

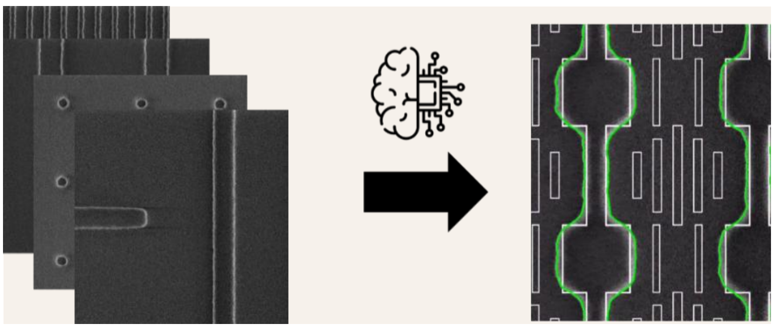
matthew.bryan@cea.fr

nicolas.bernier@cea.fr

Patterning

SL-DRT-26-0600

Statistical optimization and calibration of lithography model



Description
You are curious and eager to contribute to the advancement of cutting-edge technological nodes? Join the dynamic team of researchers and engineers at the Laboratory of Computational Patterning (LPAC) of CEA-LETI to develop and optimize photolithography models. This thesis provides an opportunity to develop statistical methods to optimize and calibrate lithography models used to generate optimal photomask designs by mean of optical proximity correction (OPC).

Microelectronic devices with high circuit density are in high demand and are extensively researched and pursued by industries. One way to achieve higher circuit density is to decrease pattern dimension or pitch. However as pattern dimension decreases, fabrication challenge increases. Resolution Enhancement Technique (RET) such as OPC has therefore to be used to generate photomask of such circuits.

OPC aims to improve the wafer pattern fidelity by compensating errors arising due to optical or process effects during fabrication steps. To implement this correction, a lithography model has to be generated taking into account the exposure system and photo resist characteristics. These models are calibrated using very large volume of experimental data which includes CD-SEM measurements and contour extracted from SEM images. The data acquisition and image post processing is a bottleneck in model calibration flow, consuming huge amount of time and resources.

During 3 years period of thesis, you will be working on:
- Innovative test patterns to optimize input data for model calibration
- Statistical and algorithmic optimization of model calibration flow
- Impact of experimental data variability on lithography models

Candidate Profile:
With a Master or engineering degree in physics, microelectronics, or nanoscience and strong interest for technological research. You are curious, eager to learn and possess strong communication skills. You are easy with French or English language.

Required skills :
Physics, Micro-electronics, Lithography, Applied Mathematics, Python scripting

 # Microelectronics
 # Lithography
 # Modeling
 # Mask Data-Prep

Application

- Sub-10nm node technology
- Metasurface

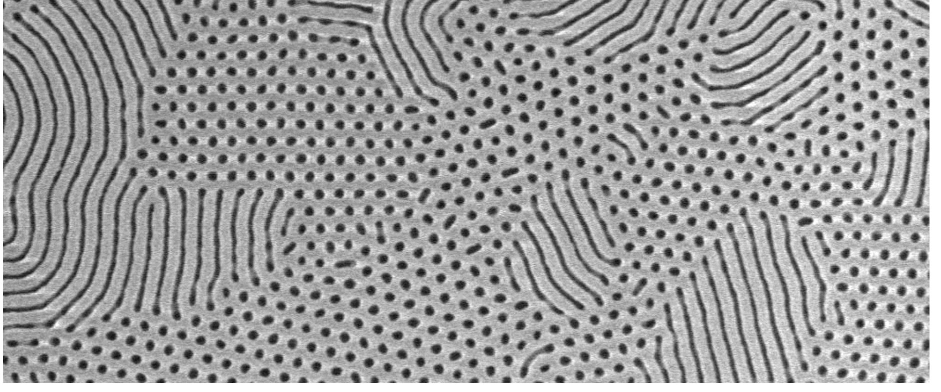
Contract

- Period: 3 years
- Starting Date: 09/2026
- Place of work: CEA-LETI, Grenoble, France

To apply, please contact:
ujwol.palanchoke@cea.fr

SL-DRT-26-0348

Advanced Metasurface Fabrication through Block Copolymer Self-Assembly



Context :

In the field of microelectronics, the miniaturization of components is a major challenge. Block copolymers (BCPs) represent a promising and cost-effective alternative to current techniques. These polymers have the ability to self-assemble to create ordered patterns with dimensions under 40 nanometers, such as lines or arrays of holes. However, each type of BCP can only form a single type of pattern (lines, holes, or pillars). Recent research shows that it is possible to combine different BCPs to create both lines and holes in a single step, but these patterns are randomly distributed across the chip.

The goal of this PhD is to solve this random distribution issue. The approach involves creating chemical guides on the substrate to direct and localize the self-assembly of each copolymer (a process called Chemoepitaxy). This innovative approach will diversify applications for optical devices by offering more efficient and cost-effective solutions.

Why do a PhD at CEA-Leti?

CEA-LETI offers you a unique opportunity to discover the research environment while immersing yourself in the industry. This experience will allow you to train on state-of-the-art equipment for both production (lithography) and characterization (SEM, ellipsometry, etc.). It is also a chance to explore microelectronics and much more, as the Grenoble center covers a wide range of research topics that you can discover.

By joining us, you will have the opportunity to present your work at numerous national and international conferences, enhancing your visibility and networking opportunities. Additionally, you will benefit from a range of advantages designed to support your professional and personal growth, including flexible working conditions that ensure an optimal work-life balance (CSE, remote work, RTT, etc.).

 # Microelectronics
 # Block Copolymer
 # Lithography
 # Patterning

Profil:

- Student: Master's degree or engineering school specializing in materials or nanotechnology.
- Analytical skills, scientific curiosity.
- Experimental aptitude.

Contract:

- Duration 3 years
- Expected date: 10/2026
- Based on: CEA-Leti Grenoble

Further information:

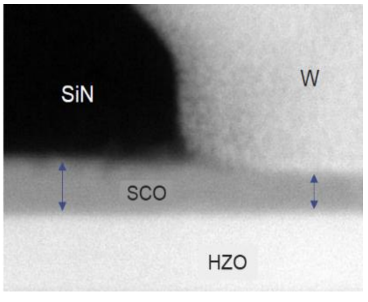
- Video block copolymers: Here
- Cleanroom CEA-Leti: Here

Contact us:

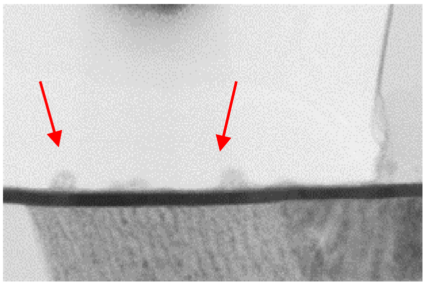
Raphael.feougier@cea.fr

SL-DRT-26-0544

Study and development of innovative etch processes to reduce the impact on indium-based semiconductor oxides for FeFET memories



STEM picture showing SCO consumption in contacts



STEM picture showing post-etch residues on top of SCO

Context :

Ferroelectric transistors (**FeFETs**) rely on the use of an **indium-based semiconductor oxide (SCO)** as the channel material. This layer, less than 10 nm thick, is sensitive to the chemical environment and temperature to which it is exposed. During FeFET integration into the **BEOL** (Back-End-Of-Line), it is necessary to **etch dielectric layers by plasma landing on the SCO layer** to create the transistor's electrical contacts. The SCO exposed to the etch and stripping plasmas can be **consumed and altered**, rendering the SCO contacts non-functional.

The goal of this PhD is to **characterize the physico-chemical, structural and electrical properties** of indium-based SCO layers exposed to different etching and stripping plasmas using XPS, XRR, XRD, AFM analyses as well as electrical tests.

In parallel, an **analysis of the contamination** of the contact etch reactor by indium will be carried out by XPS and TXRF, in order to evaluate **plasma cleaning protocols** in order to effectively remove the indium from the etch equipment, which is crucial for the manufacture of this technology in a 300mm cleanroom.

Required skills :

Master's degree or engineering degree in material science, microelectronics, plasma processes

 # Microelectronics

 # Plasma etch

 # Nano-characterization

 # Non-volatile memory

 # FeFET

Application & societal impact

- Low power non-volatile memories
- Low GWP emission processes

Further info

- https://doi.org/10.1063/5.0090120
- http://dx.doi.org/10.1088/1361-6528/ac189f
- https://doi.org/10.1016/j.mtcomm.2023.105591

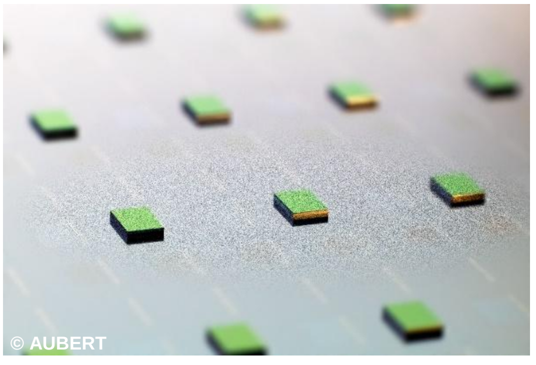
To apply, please contact:

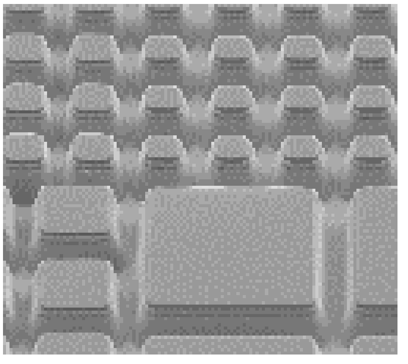
romuald.blanc@cea.fr

Job offers / **PhDs**

SL-DRT-26-0533

Reducing damage and loading in high aspect ratio III-V etching





 # microelectronics
 # III-V semiconductor
 # Plasma etching
 # High aspect ratio

Context:

The applications of III-V semiconductors are expanding rapidly, from high-efficiency photovoltaics to datacom, quantum photonics, and image sensors. To meet the growing demand, efficient and cost-effective production methods for integrated circuits are essential. This thesis focuses on advancing plasma etching processes for III-V semiconductors to create High Aspect Ratio (HAR) patterns on large wafers, from 100 to 300 mm in diameter. The research aims to address two main challenges: understanding how etching process windows evolve with the amount of material etched and the nature of the etching process, and minimizing electrical damage induced by HAR etching.

To accomplish this mission, physical and electrical characterisation methods are available, such as SEM, XPS, FIB-EDX and photoluminescence.

The candidate has three years to meet this technological challenge. She or he will work in a cutting-edge technological and clean room environment, in contact with industry leaders in the Grenoble region.

Required skills:

Understanding of semiconductor fabrication flow, interest in experimental sciences, oral fluency and ability to write summaries and scientific articles, theorical knowledge on plasma etching and Python programming are an advantage

Application & societal impact

- Photonic integrated circuits
- Image sensors

Further info

- CEA-Leti - Plateforme photonique
- Dive into world-class semiconductor clean room

To apply, please contact:
sophie.barbet@cea.fr
francois.boulard@cea.fr

Contacts

Materials and Processes	Jean-Michel.Hartmann@cea.fr
	Vincent.Jousseaume@cea.fr
Characterization	Olivier.Renault@cea.fr
Methodes	Fabrice.Nemouchi@cea.fr
Patterning	Francois.Boulard@cea.fr
Photonics	Berangere.Hyot@cea.fr

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17 avenue des Martyrs, 38054 Grenoble Cedex 9, France
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