Saint-Martin-d'Hères, le 15 mars 2022

Université Grenoble Alpes

Direction générale des services
Direction des affaires juridiques et institutionnelles

Extrait des délibérations
du Conseil d'Administration de l'Université Grenoble Alpes
Séance du mardi 15 mars 2022

N°18– D. 15.03.2022

L'an deux mil vingt-deux, le quinze mars à neuf heures, le conseil d'administration de l'Université Grenoble Alpes était rassemblé en séance plénière sous la présidence de Monsieur LAKHNECH Yassine, président.

Point à l'ordre du jour :

7.1.2. Création de l'*International research laboratories Japanese-French alliance for Semiconductor physics and Technology (IRL J-F Ast)*

Membres présents : LAKHNECH Yassine, BERRUT Catherine, MERMILLOD Martial, SCOLAN Virginie, MERLE Elsa, BARBIER Emmanuel, BERZIN Corinne, SCHWARTZ Jean-Luc, LAMBLIN Jacob, LETUE Frédérique, LE ROY Anne, BESSIERES Bernard, ADAM Véronique, VINCENT Thierry, DEVILLERS Thibaut, RIFFARD Coline, FORESTIER Gérard, CHALON Nathalie, BORRAS Isabelle, MICHEL Mickaël, WITINDI Matis, JANAMI Selma, WARIN Malo, CHARLETY Arthur, VAN DER BEEK Cornelis, SAMSON Yves, DESPREZ Frédéric, FEIGE Jean-Jacques, SIMIAND Marie-Christine.

Membres représentés : TERRIER Laurent (donne procuration à RIFFARD Coline), BAILE Henri (donne procuration à VAN DER BEEK Cornelis), PUGEAT Véronique (donne procuration à SAMSON Yves), BOLF Edith (donne procuration à BORRAS Isabelle), VERNAY Pascale (donne procuration à FEIGE Jean-Jacques), DAUGUET Pascale (donne procuration à BERRUT Catherine), LABRIET Pierre (donne procuration à MERMILLOD Martial), SCOTTO D'ARDINO Laurent (donne procuration à Jean-Luc SCHWARTZ), PERSICO Simon (donne procuration à MERLE Elsa), DELACOUR Charlène (donne procuration à WARIN Malo), CORVAISIER Bénédicte (donne procuration à DEPREZ Fréderic).

Membres absents ou excusés : tous les autres membres.

Vu les statuts de l'UGA et notamment l'article 16,

Vu l'avis favorable du conseil scientifique de Grenoble INP du 18 novembre 2021,

Vu l'avis favorable du conseil du pôle PEM du 29 novembre 2021,

Vu l'avis de la Commission de la Recherche de l'UGA du 20 janvier 2022,

Vu l'avis du Comité Technique de l'UGA du 15 février 2022,

Vu les avis des conseils des composantes académiques et des pôles de recherche concernés,

Vu le passage en directoire de l'UGA du 18 février 2022,

Vu le passage en commission permanente de l'UGA du 3 mars 2022,

Considérant le projet de création de la structure *International Research Laboratories Japanese-French alliance for science and technology* (IRL J-F Ast) entre l'UGA, le CNRS et l'Université de Tsukuba ;

Considérant les principes encadrant la création de cette structure en annexe ;

*Il est proposé au conseil d'administration d'approuver la création de l'*International Research Laboratories Japanese-French alliance for Semiconductor physics and Technology *(IRL J-F Ast).*

Le résultat du vote est le suivant :

Membres en exercice	42
Membres présents	28
Membres représentés	11
Nombre de votants	39
Voix favorables	39
Voix défavorable	0
Abstention	0

Après en avoir délibéré le conseil d'administration approuve, à l'unanimité de ses membres présents et représentés, la création de l'*International Research Laboratories Japanese-French alliance for Semiconductor physics and Technology* (IRL J-F Ast).

Publié le : 04/04/2022

Transmis au Rectorat le : 04/04/2022

Fait à Saint-Martin-d'Hères, le 15 mars 2022

Pour le Président et par délégation

Pour le Président
et par délégation
—
Le Directeur général des services
Jérôme PARET

Le Directeur général des services,
Jérôme PARET

La présente délibération peut faire l'objet d'un recours devant le Tribunal Administratif dans un délai de deux mois à compter de sa publication.

AGREEMENT FOR THE CREATION OF AN INTERNATIONAL RESEARCH LABORATORY

"Japanese French lAboratory for Semiconductor physics and Technology" –

"IRL *J-F AST*"

BETWEEN

The **CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE**, hereinafter referred to as "**CNRS**", a public scientific and technological institution, with headquarters at 3, rue Michel-Ange 75794 Paris Cedex 16, France, represented by its Chairman – Chief Executive Officer, Pr. Antoine Petit,

And

The **UNIVERSITY OF GRENOBLE ALPES**, hereinafter referred to as "**UGA**", a public scientific, cultural and professional institution, with headquarters at 621 avenue Centrale 38400 Saint-Martin-d'Hères, France, represented by its President, Pr. Yassine Lakhnech,

AND

THE UNIVERSITY OF TSUKUBA, hereinafter referred to as "**UT**", a national university corporation, whose registered address is Faculty of Pure and Applied Sciences 1-1-1 Tennodai, Tsukuba-Shi, Ibaraki-ken 305-8577 Japan, represented by its President, Pr. Kyosuke Nagata ,

Hereinafter referred to jointly as the "Parties" or individually as the "Party",

In view of CNRS decision number 920520SOSI of 24 July 1992, as modified, relating to operational structures for research,

In view of CNRS decision number 920368SOSI of 28 October 1992, as modified, relating to the formation, composition, authority and operating of the laboratory councils of operational structures for research and operational structures for service of the CNRS,

In view of CNRS decision number XXX of XXX relating to the creation of the aforementioned international research laboratory as an international joint research unit,

In view of the Agreement for the implementation of the 'Campus In campus' (CiC) initiative signed between the communauté Université Grenoble Alpes and University of Tsukuba, on November 22, 2017,

PREAMBLE

The creation of the CNRS International Research Laboratory *J-F AST* (Japanese French lAboratory for Semiconductor physics and Technology) results from a long-lasting collaboration between the two universities in

Tsukuba and Grenoble, in the field of education and scientific research. The collaboration started in 1997, and a Memorandum of Understanding (MoU) was first signed in 2002, and subsequently renewed regularly. In April 2016, an International Education and Research Laboratory Program was initiated by the University of Tsukuba in the framework of a Top Global project and settled down in 2017 within a Campus-In-Campus (CiC) collaborative action plan between UT and UGA. A joint development agreement was concomitantly signed between Air Liquide and the University of Tsukuba, with a strong technical and financial support from Air Liquide to this laboratory.

The main objectives are to strengthen state-of-the-art research activities in Tsukuba in the field of both fundamental nano-physics and technological devices and to develop international educational collaborative programs via student exchanges and master or PhD double degrees.

ARTICLE 1 – PURPOSE OF THE AGREEMENT

An international research laboratory is hereby created between the Parties, called: “International Research Laboratory Japanese French lAboratory for Semiconductor physics and Technology” or simply “IRL J-*F AST*””, and referred to as the “Laboratory”

Details of the scientific Program of this Laboratory, hereinafter referred as “Program”, are provided in Annex 1, which is attached to this Agreement.

The Laboratory is placed under the joint responsibility of the Parties, which provide it with staff and resources. It is located at Tsukuba, Japan.

The Laboratory’s CNRS code number is: XXX

It is not the purpose nor effect of the Agreement, and nothing herein may be construed in this respect, to form, create, make effective or even acknowledge the creation of a joint venture, a mandate, a company, and interest group or any other commercial group or entity, or a de facto company between the Parties.

ARTICLE 2 – TERM – RENEWAL – TERMINATION

This Agreement is executed for a five (5) year term as from January 1st, 2022. It may be renewed by amendments for subsequent five (5) year terms.

On exceptional and justified grounds, the Laboratory may be terminated prior to the end of a five (5) year contractual term with a year’s notice. In this case, the Parties shall endeavour to successfully complete the joint initiatives which have been started.

The renewal, or non-renewal, or termination decision is taken by the Parties following an opinion from the Parties’ relevant statutory bodies, the Laboratory Council and Steering Committee as defined hereinafter.

Notwithstanding the expiry or termination of this collaboration, the provisions of the articles covering Publications, Results and Confidentiality shall survive.

ARTICLE 3 – MANAGEMENT OF THE LABORATORY

The Director of the Laboratory, hereinafter referred as the “Director”, is appointed jointly by the Parties for a five (5) year term, renewable on a maximum of one (1) occasion, following the opinion of the relevant statutory bodies. Should the term of office be interrupted, the Director replacement shall be appointed according to the same procedure.

On the signature date of this Agreement, the Director of the Laboratory is Pr. Shinji KURODA, Professor at UT. The Director is assisted by a Deputy Director of the Laboratory, hereinafter referred as the “Deputy Director”, who, on the signature date of this Agreement, is Dr. Marceline BONVALOT, Associate Professor at UGA. The Deputy Director is appointed by the Parties for the term of this Agreement. Should the term of office be interrupted, the Deputy Director replacement shall be appointed according to the same procedure.

The Director is responsible for managing all the resources provided to the Laboratory and approve any secondment of staff to the Laboratory and all the resources allocated to the Laboratory by third parties. The Director is responsible for choosing trainee researchers.

At mid-term of this Agreement, the Director drafts an activity report, which is sent to all Parties.

ARTICLE 4 – STEERING COMMITTEE

The Laboratory has a Steering Committee, composed of four (4) members, with entitlement to vote:

- The Institute of Physics of CNRS Director or his/her representative
- The University of Grenoble Alpes President or his/her representative
- Two representatives named by the University of Tsukuba

Two (2) Members from Air Liquide Laboratories in Japan, chosen from outside the Parties, appointed by joint agreement between the Parties for their expertise. They sit in an advisory capacity.

The Director and the Deputy Director assist the Steering Committee in an advisory capacity.

The chairman of the Steering Committee is appointed by the Parties from one of the Steering Committee members. The term of office of the Steering Committee members is five years.

The Steering Committee meets at least once a year at the initiative of the Director and as often as the interests of the Laboratory need it at the request of the Director or at the initiative of the Steering Committee members. Should it be impossible to physically hold a Steering Committee meeting, decisions of the Steering Committee may be adopted by teleconferencing or by written or electronic consultation.

The decisions of the Steering Committee are unanimously adopted by its members.

The Steering Committee approves the provisional budget and the financial and scientific reports every year.

It makes suggestions concerning the scientific directions of the Laboratory and verifies implementation thereof. It shall:

- assess the Program’s implementation as well as its status and progress;
- make recommendations as to the research programs within the Laboratory and the requests for resources required to conduct them.

The Steering Committee may also examine all other matters relating to the Laboratory. In particular and if needed, the Steering Committee can draft rules of procedure for the Laboratory in consistency with the Parties applicable bylaws.

ARTICLE 5 – LABORATORY COUNCIL

5.1. Composition

A General Assembly composed of all staff members is put in place as a Laboratory Council.

5.2. Missions and running

The Laboratory Council, chaired by the Director of the Laboratory, will be an advisory body. In particular, it will provide its opinion on any measure relating to resources, the organization and operations of the Laboratory and, more generally, on any matter that the Director of the Laboratory considers appropriate to refer to it.

The Laboratory Council shall meet at least three times a year and such meetings shall be convened by its chair, either at his/her initiative, or at the request of a third of its members. Following an invitation from the chair, it may hear any person involved in the work performed within the Laboratory or called as an expert in respect of an item on the agenda.

As and when required, by-laws dictate the other operating rules.

ARTICLE 6 – ALLOCATION OF RESOURCES

During the term of this Agreement, the Parties shall provide the Laboratory with material research resources, which are not subject to any allocation or which are allocated for specific, jointly defined Laboratory assignments.

During said term of the Agreement, the Parties shall endeavour to keep these resources at a real level, which is at least equivalent both in terms of staff and credits. Should a reduction in resources seem nevertheless necessary, such must be justified.

The Parties second staff to the Laboratory. A list of the staff allocated to the Laboratory is attached in annex 2 to this Agreement. The Director updates this list every year and forwards it to the Steering Committee.

The Parties shall keep each other mutually informed of staff movements: either Party may, within fifteen (15) days, provide the other with its justified objection to the secondment of personnel.

In the event of a noticeable increase in the number of staffs seconded to the Laboratory, a reassessment of the material resources required is carried out by the Parties together with the Director.

Regarding its staff, each Party remains bound by all the responsibilities and obligations relating to its capacity as employer.

The staffs allocated to the Laboratory are subject to the disciplinary procedures in force in the Laboratory, without in any way altering their rights and duties under their respective statuses.

UT provides the Laboratory with the premises located at University of Tsukuba, a detailed description of which appears in Annex 3 hereto, and ensures the maintenance for which the owner is responsible. Infrastructure expenses are specified in the provisional budget of the Laboratory, once the Parties have agreed as to their nature and amount.

ARTICLE 7 – PUBLICATIONS

7.1. Reference to publications

Publications by the staff allocated to the Laboratory shall mention the connection with the institutional affiliations:

- Name of author(s)
- Japanese-French lAboratory for Semiconductor physics and Technology *J-F AST* – CNRS - University of Grenoble Alpes – University of Tsukuba - International Research Laboratory, code number XXX.

7.2. Communication

The Parties wish to improve the visibility of research work and equip themselves with tools enabling the amount of publications and scientific renown of their laboratories to be reliably gauged. To this end, the Parties undertake to implement a system for the filing of researchers' publications in electronic format, in particular, in an open archive system such as HAL.

Subject to the respect of the Confidentiality provisions set forth in Article Confidentiality, any and all communication to the public related to the work carried out in common within the Laboratory shall be subject, during the term of this Agreement and for two years after its expiry date, to the agreement of the other Party. In the absence of any objection within two months after the receipt of the draft publication by the other Parties at the latest, agreement shall be deemed to have been given.

Consequently, all draft publications or communications are referred for the opinion of the other Parties that may remove or change certain information, the disclosure of which could compromise industrial and commercial use, under optimum conditions, of the results of the work carried-out in common within the Laboratory. Such removals or changes shall not compromise the scientific value of the publication or the communication.

Moreover, one Party shall be able to ask for a delay in publication or communication of a maximum period of 18 (eighteen) months as and from the demand, if some information contained in such publication or communication have to be protected under industrial property rights.

ARTICLE 8 – LABORATORY NOTEBOOKS

Pursuant to a quality policy, the use of laboratory notebooks is mandatory in the laboratory.

The Laboratory notebooks are owned jointly by the Parties.

The Director is responsible for the notebooks' rules of use and in this respect, the Director shall ensure, in particular, that the notebooks are archived.

The Director can authorise copying for the personal use of the authors of the notebooks.

ARTICLE 9 – PARTNERSHIP AGREEMENTS

The partnership agreements which the Laboratory wishes to conclude with third parties shall be signed by all Parties, unless otherwise agreed upon by the Parties in a written separate mandate.

They will be negotiated then managed by one Party, as designated by the Director.

During the negotiation, a final draft of these agreements shall be communicated to the other Parties who shall be given thirty (30) days to confirm their approval on this version. Subsequent to this thirty (30) day period, the opinion is deemed to be favourable.

Partnership agreements may be concluded with French or European agencies (e.g. the French National Research Agency (ANR), the European Commission (EC)) or Japanese agencies (e.g. JSPS). In these cases, such agreements and, if any, their affiliated contracts (non-disclosure agreement, consortium agreement, etc.) with French agencies or European agencies shall be negotiated, signed and managed by one of the French Party in accordance with the rules of the agreements in force which bind them. Contracts with Japanese agencies shall be negotiated, signed and managed by UT.

ARTICLE 10 – NOTIFICATIONS

Each Party shall identify a designate contact to develop and coordinate the specific activities agreed upon. The designated contacts for the purposes of this Agreement shall be:

- For CNRS: dr16.spv@cnrs.fr (CNRS Delegation Paris Michel-Ange Partnership and Research Promotion Office)
- For UGA : Direction Générale Déléguée Recherche et Innovation : direction.recherche@univ-grenoble-alpes.fr
- For UT: xxx

ARTICLE 11 – RESULTS

11.1. Ownership of Results

The results, whether patentable or not, which are obtained pursuant to the Agreement, hereinafter referred to as the "Results", are the joint property of the Parties according to the following principles:

- A fixed share (30%) is allocated equally among the Parties ;
- The remainder (70%) is allocated equally among the inventors 'employers.

Each Party retains ownership of the knowledge acquired by it outside this Agreement.

Each Party is entitled to use, free-of-charge, the Results for the sole purposes of its research and for research collaboration with third parties, to the exclusion of any and all other direct and/or indirect use for commercial purposes.

Any and all Results consisting of a new patent, software or other knowledge protected by an intellectual property right, shall be subject to rules of co-ownership, that shall be drawn-up in writing between the Parties as soon as necessary and, in all cases, prior to any and all industrial and/or commercial use or exploitation.

Any transfer of ownership of the Joint Results shall require the prior written consent of the Parties.

11.2. Appointment of an Administrator Institution for the protection and exploitation of the Results

For each Result, the Parties designate an Administrator Institution (hereinafter referred as to "Administrator Institution") to be in charge of the protection and the exploitation of the Results by taking into account the expertise, the relevance of the intellectual property portfolio already owned by each Party.

The French Parties shall designate an Administrator Institution in accordance with the rules of the agreements in force, which bind them according to the French law. The Mandatory Institution represents the French Parties for the issues relating to the Results and interacts with the Administrator on these subjects.

11.3. Protection of the Results by patent

Patent applications for Joint Results are filed in the joint name of the Parties; the name of the inventor(s) shall be mentioned.

The Administrator Institution has an express mandate from the other Parties so as to manage the filing of patent applications and for obtaining and maintaining the resulting patents.

The Administrator Institution assumes responsibility for steering and monitoring the priority filing procedure and keeps the Japanese Parties and the Mandatory Institution for the French Parties informed of the progress of the application and provides the list of foreign countries in which extensions shall be filed.

Should one of the Parties waive entitlement to file or maintain a patent and/or part of the extensions effective, it shall inform the Administrator Institution thereof within a reasonable timeframe.

In addition, the waiving Party undertakes to sign or get signed any and all documents enabling the other Parties to become sole owners of the said patent(s) in question. The other Parties which continue with the procedure in their own names and shall be the sole beneficiaries of any income generated by use of the patent in the countries for which the other Party waived entitlement to continue with the procedure.

The Administrator Institution shall bear all charges relating to the filing, issue procedure and continuance in force of the jointly owned patents, together with those incurred for any extension abroad.

11.4. Exploitation of the Results

The Administrator Institution receives an express mandate from the other Parties to carry out all exploitation-related work. In particular, it negotiates contracts on behalf of the Parties with all companies wishing to exploit the Results.

The Administrator Institution shall keep the Japanese Parties and the Mandatory Institution for the French Parties, regularly informed of the results of the canvassing or its negotiations. Any licensing agreement shall be signed by Administrator Institution, on behalf of the other Parties.

The Administrator Institution shall repay to the other Parties, a proportion of the Net royalties resulting from the exploitation of the Result(s). The repayment proportion is based on the repartition of the joint ownership provided for in Article 11.1. The Net royalties are defined as the royalties resulting from the exploitation of the Result(s) after reimbursement of the proceeding costs paid by the Administrator Institution and less a compensation for the exploitation efforts of the Administrator Institution representing twenty per cent (20%) of the balance after deduction of the proceeding costs.

When the cumulative income of an invention exceeds 500 k€, the Parties may decide to renegotiate between themselves the distribution of income shares, taking into account in particular the costs of accommodation, use of equipment, etc. If no agreement is reached within a maximum period of two months, the repartition provided for in Article 11.1 continue to apply.

11.5. Software

Derived Software without substantial modification

Software created on the basis of prior software owned by one of the Parties (hereinafter "the Existing Software) in the context of this Agreement (hereinafter referred as to "Derived Software") are the property of the Party owning the Existing Software concerned, irrespective of who the author is, only if the modifications are considered not substantial. When the Party that has made such modifications to an Existing Software is not the owner of said Existing Software, it undertakes to assign exclusively the economic rights over the Derived Software to the Party owning the Existing Software for no financial consideration for all countries and for the legal duration of the intellectual property rights.

Derived Software with a substantial modification

A Derived Software with a substantial modification of an Existing Software is constituted by a different executable code that is independent and which can be executed in a separate address space; the Derived Software and the Existing Software calling each other while being executed.

All the new software and Derived Software other than "Derived Software without substantial modification" are jointly owned by the Parties in accordance with the article 11.1. Their conditions of protection and exploitation are the same as the patents.

11.6 Databases

In case of new important investments (intellectual, material or financial) made by a Party to the databases owned by another Party, the Parties will discuss the sui generis rights.

All new Database is jointly owned by the Parties in accordance with the article 11.1 and the same conditions of protection and exploitation as for the patent, are applicable.

11.7. Results infringement actions

In the event of an action for infringement by a third party against the Results, a declaration of invalidity, the Parties shall act together to jointly agree on the strategy to adopt.

The Parties shall supply each other with all the evidence in their possession permitting an evaluation of the nature and extent thereof.

In the event of it not being possible to obtain a consensus, each of the Parties may on its own and at its own expenses take the actions which appear to it appropriate. In this event, any compensation resulting from such actions ordered by the court shall wholly and irrevocably be the property of the Party acting.

The Parties, undertaking or not legal action, shall provide all the documents, proxies or information necessary to the other Parties undertaking legal action for the matters referred to above.

ARTICLE 12 – CONFIDENTIALITY

The Parties undertake to ensure that the information exchanged pursuant to the Agreement and identified as confidential (hereinafter referred to as the "Confidential Information"):

a) is kept strictly confidential and is protected to the same extent as their own Confidential Information;
b) is only provided to their members of staff requiring knowledge thereof and is only used in application of this Agreement,

Any and all other communication or use of the Confidential Information is subject to the prior and written authorisation of the communicating Party. Each Party undertakes to ensure that its staff referred to in section b) hereinabove comply with the provisions of this Agreement.

These provisions shall remain in force for a period of five years after the termination of the Agreement.

Notwithstanding the foregoing provisions, each Party may provide Confidential Information for which it is able to prove:

- that it was in the public domain prior to its communication or subsequent thereto, but without any breach being attributable to it;
- that it was received legally from a third party;
- that it was already in its possession prior to the execution of the Agreement;
- that it was developed independently and in good faith by its members of staff who did not have access to said Confidential Information;

Moreover, these provisions may not preclude:

- either the obligation binding on all personnel involved in the researched programs performed within the Laboratory to provide an activity report to the establishment to which they report, provided such communication does not represent disclosure within the meaning of industrial property legislation;
- or the defence of the thesis related to the Program of this Agreement with such defence being organised whenever necessary so as to guarantee the confidentiality of the Results.

ARTICLE 13 – LIABILITY

Each Party remains liable, without a right of action against the other Parties, with the exception of cases of gross or intentional negligence, for repairing damage to its own property owing to during the performance of this Agreement.

According to the rules of ordinary law, each Party is liable for damage / loss of any nature caused to third parties during the performance of this Agreement.

ARTICLE 14 – SETTLEMENT OF DISPUTES

The Agreement is governed by the legislation of the country where the Laboratory has its location.

The Parties shall endeavour to settle their differences out of court in an amicable way.

Should they fail to do so, any disputes may be settled in accordance with the rules of conciliation and the arbitration of the International Chamber of Commerce, under the aegis of one or more arbitrators appointed pursuant to these rules.

The Agreement is drafted in English, in three (3) originals

In Paris, on

For CNRS

Antoine Petit,
Chairman – Chief Executive Officer

In Tsukuba, on

For University of Tsukuba

Prof. XXX

In Grenoble, on

For University of Grenoble Alpes

Prof. XXX

ANNEX 1: SCIENTIFIC PROGRAM

J-F AST

Japanese - French lAboratory

for Semiconductor physics and Technology

Shinji Kuroda - Marceline Bonvalot - Etienne Gheeraert - Henri Mariette
- September 15th, 2021 -

This IRL involves a core research program dedicated to fundamental physics of advanced electronic and opto-electronic devices, with a particular focus on atomic scale processing physics and technology, supported by a strong involvement of Air Liquide Company.

The following document presents this core research project and lists a few collaboration themes currently under development between CNRS, UGA and UT.

Core Research Scientific Project

The aim of the proposed International Research Laboratory is to develop innovative physics and technology dedicated to advanced semiconductor devices. This requires combining fundamental physics investigation on emerging semiconductor materials with leading atomic scale processing technologies. With the ongoing miniaturization of semiconducting devices, atomic scale surfaces and interfaces become dominant in device fabrication and operation, and a deep fundamental knowledge of their physical properties and behavior is essential for the accurate control of devices. Atomic scale processes allow accurate control of the shape, defects and crystalline quality of semiconducting materials. Such processing technologies become a key asset for the fabrication of semiconductors with defect free properties and quantum devices with well-controlled structure and interfaces. For instance, it is expected that electronic transistors will have larger mobility because of less defective surfaces, and opto-electronic devices lower surface recombination.

Studies include wide bandgap semiconductors (GaN, diamond, Ga_2O_3), new medium bandgap semiconductors for photovoltaics ($BaSi_2$, kesterites), and narrow bandgap semiconductors (CdTe/ZnTe) for solid state spin qubits.

Semiconductor nanostructures for single dopant spin devices

Thanks to their long coherence time, individual localized spins in semiconductors are promising *qubits* for implementation in emerging solid-state quantum technologies, including quantum computing and quantum-enhanced sensing. However, achieving long-range interaction between remote solid-state spin qubits, as well as placing individual localized spins from dopants or defects at specific locations, both essential elements of quantum device fabrication, are still challenging goals, as of today. Phonon assisted spin-spin coupling in a mechanical resonator has been suggested as a promising route to mediate coherent interaction between localized remote spins. Surface Acoustic Waves (SAW) and phonon-like excitations bound to the surface of a solid are also proposed as efficient quantum bus enabling long-range coupling of a wide range of qubits. Developing such hybrid spin-mechanical systems will require identical spin qubits with large intrinsic spin to strain interaction.

Some magnetic atoms, as Chromium (Cr) incorporated in II-VI semiconductors are also strongly sensitive to lattice deformation. The spin of such individual magnetic atom can be optically probed when inserted in a quantum dot. We want to investigate on the possibility of using the spin of individual magnetic atoms in a semiconductor quantum dot as an optically addressable qubit for hybrid spin-mechanical systems. The large intrinsic spin to strain coupling of chromium should enable the use of its interaction with the strain field of a SAW for the mechanical driving of a single spin. Under high intensity SAW excitation, this system will allow studying a single spin in the sought-after *strong driving* regime, where the Rabi energy $\hbar\Box_{Rabi}$ is larger than the energy splitting of the qubit $\hbar\Box_{B}$ (i.e. beyond the standard rotating wave approximation). This in turn will shed light on this exciting but still under-explored area of quantum physics.

We will determine the efficiency of the dynamical spin to strain coupling at the single atom level and mechanically probe the coherence of this spin qubit. This will enable the design of the mechanical resonator needed to reach the spin-phonon strong coupling regime for an individual Cr (cooperativity larger than 1). We will analyze the conditions required to reach and detect this coupling regime with a single phonon in a realistic high quality factor SAW resonator realized on II-VI samples. Such device will allow a coherent coupling between remote identical spins mediated by the interaction with the confined phonon mode of the resonator. For a cooperativity lower than 1, the large spin to strain coupling of Cr will nevertheless allow to observe collective effects between an ensemble of N identical spins and a single SAW cavity mode. Spin/phonons polaritons (Dicke model) should be observed and a bistability regime should be reached under mechanical driving of the cavity.

In case these quantum dots with a single magnetic atom are grown as a slice of thin nanowires (to better control their position), Atomic Scale Processing will be a key technology to avoid surface traps.

Wide band gap semiconductor physics for electronic devices

III-V nitrides: Molecular Beam Epitaxy of GaN will be carried out in Grenoble and subsequent defect characterization by Positron Annihilation Spectroscopy (PAS) in Tsukuba. Fabrication of AlGaN/GaN quantum well for light emission, improvement using atomic scale processing to reduce surface defects.

Diamond: CVD growth of diamond in Grenoble, and defects characterization by Positron Annihilation Spectroscopy (PAS) in Tsukuba. In particular, impact of heavy boron doping (>10^{20} cm^{-3}) on vacancy-type defects above metallic transition will be studied.

Ga_2O_3: Development of heterostructures of Ga_2O_3 on sapphire, including Al_2O_3/Ga_2O_3 quantum wells. Development of technological processes for the production of high quality surface and interfaces.

Oxides: Deposition of thin insulators on wide bandgap semiconductors (Diamond, SiC, GaN). Interface and bulk defects in insulator, along with their interaction with the underlying semiconductor.

The preferred growth process will be Atomic Layer Deposition, with specifically developed precursors from ALL. Complementary physical and electrical thin film characterization (XPS, XRR, AFM) will be carried out in Grenoble.

New semiconductors for photovoltaics:

$BaSi_2$

$BaSi_2$ is a promising, low-cost, earth-abundant material with large optical activity for potential application in thin-film solar cells.

- Preparation of $BaSi_2$ semiconductor thin films in Tsukuba
- Defect characterization by ESR in Grenoble using the high-field / high-frequency ESR spectrometer (LNCMI) and an X- and Q-band pulsed EPR spectrometer (SYMMES).

Deconvolution of spectra for defect characterization will be greatly improved thanks to the g tensor resolution provided by the HF setup. Pulsed EPR sequences (ENDOR, HYSCORE) will allow further characterization of defect chemical environment.

Kesterites alloys $Ag_2ZnSnSe_4$ and $Cu_2ZnSnSe_4$

$Cu_2ZnSn(S,Se)_4$ (CZTSSe) semiconductor materials are promising candidates for potential application in thin film solar cells because they are made of earth-abundant elements. However, their power conversion efficiency (typically of the order of 12%) remains quite low in comparison to similar absorbing materials (Cu(In,Ga)(S,Se), 22% efficiency). More precisely, the limited open-circuit voltage (V_{oc}) is still an important issue in CZTSSe-based solar cells, which needs to be addressed. This is commonly attributed to the presence of strong potential fluctuations induced by a large amount of intrinsic point defects : the high level of Cu-Zn cation disorder gives rise to deep anti-site levels, which causes significant fluctuations of band edges and results in band tailing at the origin of the limited V_{oc}.

Subsequent research activities will consist in testing and analyzing the impact of silver incorporation into CZTSSe. Indeed, the formation energy of the Ag_{Zn} anti-site is much larger than that of Cu_{Zn}, so that the band tailing due to such local disorder is expected to be significantly reduced.

Besides the epitaxial growth of such new $Ag_2ZnSnSe_4$ alloys, which will be carried out in Grenoble, advanced optical spectroscopy, including time resolved photoluminescence, will be developed to have a precise quantitative estimation of both band gap and energy extension of the band tail. In parallel, the growth of (Ag,Cu)ZnSnSe polycrystalline films will be carried out at the University of Tsukuba, along with a study of deep levels by admittance spectroscopy and transient photo-capacitance techniques. Admittance spectroscopy provides thermal emission rates of electrically active defects, whereas the transient photo-capacitance signal corresponds to transition from the valence band to unoccupied defect states).

Atomic Scale processes

Two main issues will be addressed in the development of atomic scale processes applied to wide band gap semiconducting materials. Wide band gap semiconductors are currently garnering worldwide research interest for potential applications in the field of power electronics (SBD, FETs, RF switches) and optoelectronics (UV-visible optical devices), owing to their unique properties, such as low intrinsic carrier density at high temperatures, high breakdown electric field (up to 10 MV/cm), and large electron-hole pairing energy. In particular, Baliga's Figure Of Merit depicting ON resistance losses (Figure 3) and Johnson' s Figure Of Merit depicting highest accessible frequency in RF power devices (Figure 4) show that not only GaN but also SiC, Ga_2O_3, and diamond are promising candidates for next generation of ultra-high-frequency/high-output power devices required for the development of 6G wireless communication networks.

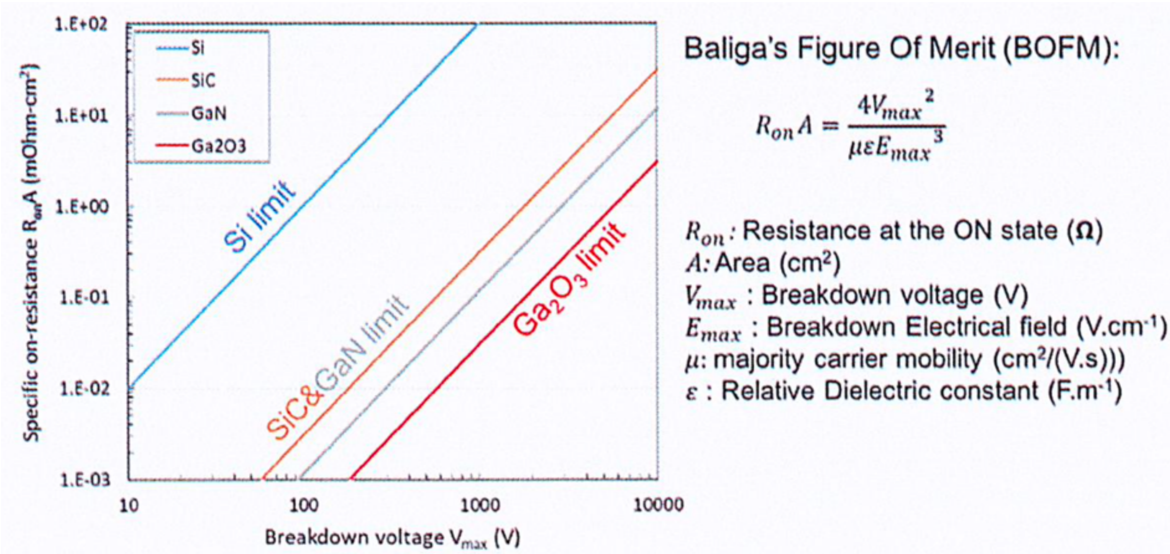

Figure 3: Theoretical ON-state Resistance vs breakdown voltage limits for various Wide Band Gap Semiconductors and definition of Baliga's Figure of Merit. source: H. Umezawa, AIST internal document

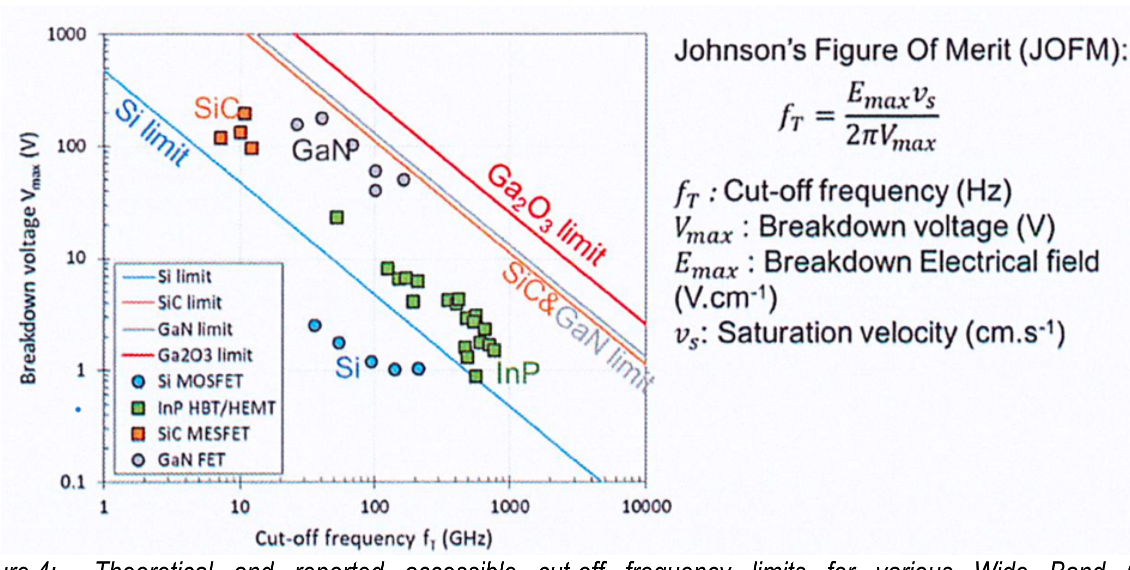

Figure 4: Theoretical and reported accessible cut-off frequency limits for various Wide Band Gap Semiconductors and definition of Johnson's Figure of Merit source: H. Umezawa, AIST internal document

However, numerous challenges have to be overcome before these materials can be implemented in power devices, such as substrate fabrication, epi-layer growth (precise control of dopants, doping levels, dopant distribution, dislocations density), etching processes (wet or dry, with low induced defect density), and integration in device arrays (control of gate thickness, nature of electrical contacts). This IRL project intends to address some of these challenges, specifically by developing atomic etching processes that should allow both **(i)** an ultimate control of etched thicknesses and (ii) a strong reduction of induced non-radiative-defects, a key point for micro-devices. In addition, know-how for the ALD of metal gate dielectrics on these materials will be developed simultaneously.

The first issue within this IRL deals with the **further development of Atomic Layer Etching processes of wide band gap semiconductors.** For this step, the experience gained from our recent collaboration on the etching of GaN will serve as a starting point to improve knowledge and know-hows for the atomic scale etching of Ga_2O_3, $AlGa_2O_3$, AlGaN, AlN and other wide band gap semiconductors, such as diamond and SiC. Achieving ALE of the above listed materials will require to first identify suitable reactive gas chemistries, understand the mechanisms at play during material- plasma interactions, optimize plasma parameters to achieve etching at the atomic scale. This issue involves the optimization of etching parameters and chemistry in order to adjust the etching selectivity with the appropriate CD control, while simultaneously preventing any plasma induced defects such as roughness, amorphization and/or chemical contamination. Special attention will be devoted to fluorine-based chemistries as a possible substitute to chlorine chemistries, which are highly corrosive and possibly detrimental to atomic scale controls of etched features. Moreover, fluorine is also known to provide adequate passivation characteristics, which may be of potential interest to atomic layer etching processes of these wide band gap materials.

The second issue concerns their **Atomic Layer Deposition** and will also be addressed within this IRL project, with the general idea of developing **a complementary field of expertise in atomic scale processes** at the University of Tsukuba. It will be conducted in a similar way as what has been successfully done on ALE, at Tsukuba for the past 3 years. For ALD development of wide band gap materials, precursors will be developed and provided by our partner Air Liquide (ALL). Processes will be optimized and strengthened at LTM in Grenoble, in terms of conformality and quality of oxide/substrate interfaces. Moreover, the electrical properties of the obtained deposits will be optimized in terms of interfacial trapped density and sign of trapped particles at the interface, based on the physical chemical and electrical properties of deposits analyzed in Tsukuba. The obtained results should help define the most appropriate combination of precursor type, substrate nature and plasma chemistry leading to the adequate wide band gap thin film for use in power devices and/or optical micro-LEDs.

This latter issue defines a strategic objective of acquiring a new ALD tool at the University of Tsukuba, to enable establishment of a broad cross-disciplinary research laboratory involving physicists, chemists, theoretical scientists and technological experts dedicated to the fabrication of advanced microelectronic, optical and power devices addressing current technological and energetic issues.

Thus, the long-term objective is to build a strong, complete and unique expertise in next generation of Wide Band Gap Semiconductors, ranging from their fabrication to fundamental investigation of their electronic properties, based on the common sharing of competence from each partner. This objective is built on both short- and mid-term projects with the development of new added-values precursors, the understanding of precursor/surface interactions and reactions, as well as plasma/precursor reaction mechanisms, leading to optimization of atomic scale processing (deposition and etching) of wide band gap semiconductor and their oxides. These projects will be achieved by taking into account highly specific targeted applications, such as power devices and/or optical devices (micro-LEDs). This overall research effort is in essence an interdisciplinary research work covering chemistry, physics and electrical engineering, both from the theoretical and experimental field of expertise, and involving both industrial and academic partners.

scientific objectives of the IRL for atomic scale processes

1. To optimize and improve the Atomic Layer Etching process developed for GaN by comparing Fluorine-based precursors to Chlorine-based precursors. The impact of Al atoms in AlGaN and AlN etching will also be studied.

2. To develop new ALE etching processes for other wide band gap semiconducting materials, such as Ga_2O_3 and diamond materials. As for GaN, the ALE process must minimize damages and defects as compared to conventional plasma etching processes. Based on optimized processes, we expect to make demonstrators of Ga_2O_3-based MESFETs.

3. To develop a new expertise on Atomic Layer Deposition. Two types of materials are concerned in this project, since they are needed for the fabrication of electrical and optical devices: Silicon- based materials, such as SiO_2, SiN and low k Si-based materials, and Metal-oxide materials. SiO_2 and SiN have already received a lot of attention from the ALD community, since they are involved in a large set of applications. However, their deposition still remains a challenging process, in terms of properties (density, H bond content, wet etching resistance...) and conformality. These properties can be optimized using a cold plasma assistance, but the deposition of very good quality and conformal materials at low temperatures (<300°C) in high aspect ratio features is still a challenge worldwide. The deposition of Si-based low k dielectrics with continuous property distribution at the nanoscale is also challenging. For metal oxides, the oxide quality, conformal deposition and oxide/substrate interface are important parameters. In addition, these oxides can be used to passivate and optimize the electrical properties of specific devices, by eg lowering the interfacial trap density and controlling the sign of the global electrical charge.

ANNEX 2: HUMAN AND FINANCIAL RESOURCES

Table 2.1 Provisional budget summary for the first year

Country	Institution	In-cash funding		Amount (€) *(include detailed budget allocation if known)*	In-kind input *(if applicable)*	Type of staff	Full-time equivalent
France	CNRS	☒ Operations ☐ Equipment ☒ Mobility	☐ Other (specify)	30 000€ operations (pending) Mobility (pending)		☒ Researcher	1.25
						☐ Postdoc	
						☐ PhD	
						☒ Support	1
	University Grenoble Alpes	☒ Operations ☐ Equipment ☐ Mobility	☐ Other (specify)	30 000€ operations (pending)		☒ Researcher	0.5
						☐ Postdoc	
						☒ PhD	3*
						☐ Support	
						☒ Master	1
Japan	University of Tsukuba	☐ Operations ☐ Equipment ☐ Mobility	☐ Other (specify)		1 experimental room + 2 offices	☒ Researcher	4**
						☐ Postdoc	
						☒ PhD	3
						☐ Master	
						☒ Support	0.2***

- ***: based on current UGA double-degree PhD student (cotutelle)**
- **** : estimated from the involvement of Japanese Professors, as indicated in the scientific project. Each participant time is evaluated as 30% FTE**
- *****: administrative staff support : 1 full day/week**

Table 2.2. Researchers involved in the IRL

Seconded Staff *(For lecturers and professors the % is of the research time)*

Researcher	Function	Laboratory	Institution	%	Comments
French staff					
Henri Mariette	**emeritus DR**	**Néel Institute**	**CNRS**	**20**	
Etienne Gheeraert	**Prof.**	**Néel Institute**	**UGA**	**40**	
Marceline Bonvalot	**MdC**	**LTM**	**UGA**	**40**	
To Be Defined				**50**	
To Be Defined				**50**	
Japanese staff					
S. Kuroda					
C. Mannequin					

IRL Collaborators

The French positions in the following table are:
CR – chargé de recherche, (junior) researcher at CNRS (permanent position)
DR – directeur de recherche, (senior) researcher at CNRS (permanent position)
Prof. – professeur des universités, (senior) professor-researcher at university (permanent position)
MdC – maître de conférences, (junior) professor-researcher at university (permanent position)
IR – ingénieur de recherche, engineer doing research at CNRS (generally permanent position)

Researcher	Function	Laboratory	Institution
French staff			
E. Pargon	**DR**	**LTM**	**CNRS**
C. Durand	**MdC**	**Néel Institue**	**UGA**

G. Jacopin	CR	Néel	CNRS
L. Besombes	DR	Néel	CNRS
H. Boukari	CR	Néel	CNRS
J. Pernot	Pr	Néel	UGA
D. Eon	MdC	Néel	UGA
A. L. Barra	DR	LNCMI	CNRS
R. André	DR	Néel	CNRS
O. Fruchart	DR	Spintec	CNRS
J. Ph. Attané	MdC	Spintec	CNRS
N. Dempsey	DR	Néel	CNRS
J. Vogel	DR	Née	CNRS
S. Pizzini	DR	Néel	CNRS
L. Laversenne	CR	Néel	CNRS
M. Holzinger	DR	DCM	CNRS
R. Auzely	DR	CERMAV	CNRS
I. Gauthier-Luneau	Prof	Néel	UGA
Cyril Train	Prof.	LNCMI	UGA
Japanese staff			
A. Traoré	Prof	Faculty of Science	UT
K. Akimoto	Prof	Faculty of Science	UT
A. Uedono	Prof	Faculty of Science	UT
T. Suemasu	Prof	Faculty of Science	UT
T. Sakurai	Prof	Faculty of Science	UT
T. Yanagihara	Prof	Faculty of Science	UT
S. Tsujimura	Prof	Faculty of Science	UT
M. Ebara	Prof	Faculty of Science	UT
Y. Tokoro	Prof	Faculty of Science	UT

The Parties shall conclude hosting agreements to allow the presence in the IRL of the staff not assigned into as referred hereinabove.
Such agreements shall preview notably as follows:

- Requirements of safety, liability and discipline ;
- Requirements of mentions in publications, confidentiality and intellectual property in compliance with this Agreement

External collaborators

IRL J–F AST continuing staff may be allowed to carry out research activities with external collaborators subject to the prior signature of specific collaboration agreements between the relevant establishments.

ANNEX 3: PREMISES

The IRL *J-F AST* premises are located at the University of Tsukuba in the department of Pure and Applied Physics. It consists in one dedicated experimental room and 2 offices for permanent staff members.