Postdoctoral position LTM/CNRS (M/F)

Development of plasma etching processes for the fabrication of high-efficiency betavoltaic sources in core-shell architecture

Key words : Plasma etching process, nitride semiconductor (AlN, AlGaN, GaN), cathodoluminescence, MOVPE process, core-shell architecture, betavoltaic source.

Context

Beta voltaic (BV) sources harness the energy produced by the radioactive decay of beta particles to generate electricity. They are made from a p-i-n structure equivalent to a photovoltaic cell, except that it is beta radiation (high-energy electrons resulting from the disintegration of neutrons into protons), and not photons from the solar spectrum, that are absorbed by the p-i-n junction and then converted into electrical energy. Unlike traditional chemical batteries, these generators have an exceptional lifespan, reaching several decades without recharging, due to the long half-life of the isotopes used, such as tritium or nickel-63. Their small size, maintenance-free operation and ability to provide stable, continuous power make them particularly attractive for critical applications such as medical implants (pacemakers), satellites, drones and on-board sensors in extreme environments. Although betavoltaic technology is very promising, it has not yet been mastered, and total power conversion efficiency does not exceed 5% [1].

The ANR Nobel project, which brings together 4 partners (LTM/CNRS, pheliqs/CEA, Institut Néel/CNRS and CREAH/CNRS), is proposing a new beta voltaic battery architecture based on wide bandwidth p-i-n junctions using nitride semiconductor core-shell nanowires (GaN, AlN, AlGaN), in order to overcome the efficiency limitations inherent in the planar architectures of current cells.(see Figure 1)

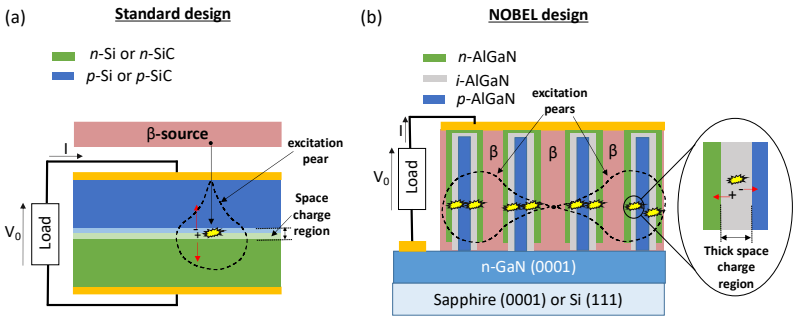

Figure 1: (a) Conventional planar architecture of a BV battery. (b) 3D architecture proposed by the NOBEL project.

In this context, the aim of the postdoctoral project is to develop and characterise plasma etching and wet etching processes for high form factor AlGaN and GaN wires, which constitute the first technological stage in the manufacture of betavoltaic sources.These wires will be used by the project partners to grow quantum wells in core-shell architecture in order to produce p-i-n junctions.

[1] C. Zhou et al., "Review—Betavoltaic Cell: The Past, Present, and Future", ECS J. Solid State Sci. Technol., 10, 027005, (2021). doi: 10.1149/2162-8777/abe423.

Tasks

The work required as part of this postdoc is to

1) Develop plasma etching processes for AlGaN and GaN wires with a high form factor
2) Develop KOH-based wet treatments to restore the etched wire surfaces

3) Characterise the processes morphologically (SEM, FIB-STEM, AFM), chemically (XPS) and optically (cathodoluminescence).

Environment

The research work will be carried out within the Microelectronics Technologies Laboratory (LTM), a CNRS laboratory located on the CEA Grenoble Minatech site, in close collaboration with the Néel Institute (CNRS-Grenoble) and the Pheliqs (CEA/IRIG-Grenoble), and the CRHEA/CNRS (Valbonne). The candidate will have access to all the reactors and characterisation techniques available in the clean rooms of the CEA/Leti where the LTM equipment is located, as well as to the optical characterisation by cathodoluminescence available at the Néel Institute. This research environment gives it the opportunity to acquire multidisciplinary skills and expertise..

Skills

The candidate must hold a doctorate. The work requires a taste for experimental work, clean-room microfabrication and a good general scientific level. Knowledge of plasma etching processes and materials characterisation is required to successfully complete the project. Knowledge of III-N semiconductor materials and semiconductor physics will also be appreciated. Matlab or Python programming skills will also be an asset. Good communication skills in French and English and the ability to report on their work are also required. The candidate must enjoy working as part of a team, while demonstrating autonomy, dynamism and rigour. At the end of this project, the candidate will have solid experience in plasma etching processes, materials characterisation, clean room manufacturing processes, optical characterisation and optoelectronics.

Practical information

- **Beginning**: june 2025
- **Duration**: 1 year (renewable)
- **Salary** : between 2991€ et 3417€ according to experience
- **Contacts :**

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Please attach a CV and lists of the most relevant publications, together with contact details of two referees.