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Doctoral project with master internship

Automatization of the characterization of crystalline defects inside Scanning Electron Microscopy (SEM): application for the GaN industry

– Contrast modeling and computer vision for microstructural defect characterizations –

The doctoral researcher will be part of the local team of the HORIZON project AddMorePower (Advanced modeling and characterization for power semiconductor materials and technologies), granted up to 6 M€ over 48 months by the European Commission.

AddMorePower aims to advance x-ray- and electron-probe related characterization techniques to make them quantitative and automated tools for the power semiconductor industry, and to refine modelling and data-management methods to enhance and efficiently use characterization data. Thereby, AddMorePower will promote the materials integration and development for European power semiconductor technologies, to allow a broader and faster market penetration, while also providing new opportunities for other industries basing themselves on mono- and poly-crystalline materials. With the rapid and massive spread of power electronics and power semiconductors to enable the digitalization and the electrification of our society and its supply with sustainable energy, new requirements arise to the conception and integration of semiconductor and interconnect materials. The project brings together renowned research institutes with many years of experience in electron- and x-ray characterization, emerging new research groups and company start-ups and researchers with a track record in multi-physics materials modelling as well as data engineering.

Scanning Electron Microscopy (SEM) can generally be used to characterize microstructural defects in crystalline materials. Electron Channeling Contrast Imaging (ECCI) allows in the sub-surface (≈ 100 nm deep) of bulk material the direct observation of crystal defects, such as dislocations [1]. This emerging SEM technique has the potential to identify contrast changes at the surface using specific crystallographic orientation rules and use them to characterize defects in a non-destructive way [2,3] but it is not yet explored for power electronics materials. The ambition is to lift ECCI to the status of a robust and non-destructive probe for crystal defects in semiconductors. To achieve that a combination of known electron imaging conditions with machine learning /computer vision-based indexing of defects and comparison with simulated data is the ambition. Subsequently, an automated procedure assisted by machine learning-based image processing combined with dynamical simulations of electron channeling contrast and Dislocation Dynamics (DDD) [4] is envisioned to open new routes for the day-to-day use of ECCI in industry.

[1] H. Kriaa, A. Guitton, N. Maloufi; SCIENTIFIC REPORTS, 2017 (9742)
[2] H. Kriaa, A. Guitton, N. Maloufi; MATERIALS, 2019, 12 (10), 1587
[3] H. Kriaa, A. Guitton, N. Maloufi; MATERIALS, 2021, 14 (7), 1696
[4] A.A. Kohnert, H. Tummala, R.A. Lebensohn, C.N. Tomé, and L. Capolungo; SCRIPTA MATERILIA, 2020,

Your skills

Required: Excellent knowledge in materials science and physics, including electron microscopy. Experience with computation languages (python, MatLab...) for modelling or simulations.

Beneficial: Experience in characterization of microstructures by electron microscopy, or in computer vision.

We offer

6 months of master internship (starting from 01/02/2023) followed by 36 months full-time doctoral contract (starting from 01/09/2023) including health care, paid holidays. Dynamic international environment. Close supervision by senior scientists. Opportunity to develop numerical skills (modeling, computer vision,…) to foster a career in academia or industry.

The local team of AddMorePower:

Dr. Antoine GUITTON (local team leader), associate professor HdR, expert in microscopy and materials plasticity. [www.antoine-guitton.fr]

Dr. Vincent TAUPIN, CNRS research scientist HdR, expert in continuum modeling of materials mechanics.

Dr. Julien GUYON, research engineer, expert in SEM and development of cutting-edge techniques

Dr. Nabila MALOUFI, associate professor HdR, expert in materials physics.

2 doctoral researchers, 1 postdoctoral researcher and Prof Laurent CAPOLUNGO (Los Alamos National Labs, USA) as collaborator

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Host laboratory of the doctoral researcher

The LEM3 laboratory (***L**aboratoire d'**É**tude des **M**icrostructures et de **M**écanique des **M**atériaux*) is a French laboratory located in Metz. As an interdisciplinary research center, the LEM3 combines solid mechanics, metallurgy, materials science, chemistry and physics. The scientific excellence of the laboratory is acknowledged by internationally recognized researchers and the combined authority of the CNRS, the Université de Lorraine and the engineering school "Arts et Métiers". The LEM3 is part of the Carnot Institute ARTS, the DAMAS laboratory of excellence (*LabEx*) and currently employs more than 250 persons.

Application

Please send a **detailed CV**, an **application letter,** and the **grades of your Bachelor+Master** to the **two emails** indicated in the header. There is no need to join recommendation letter, but please **indicate the contact information for references**.

Application without enclosures mentioned may not be accepted.