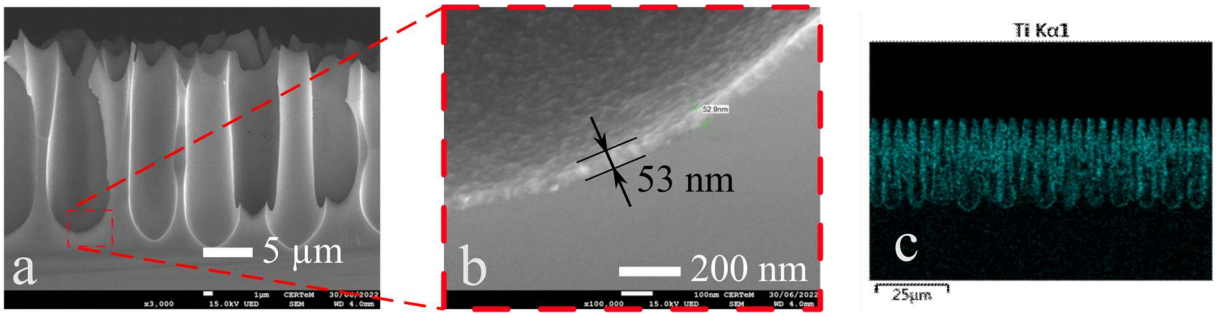
Development of large-area porous silicon synthesis process and ultrathin coating for porous nanoparticles functionalization

Lab & Context

GREMAN is a joint research laboratory of Tours University and INSA Centre Val de Loire in France. Our team works on topics related to porous silicon synthesis and its applications. Porous silicon is an interesting material currently used on research and development for numerous applications such as photonics, microelectronics or biotechnologies. The laboratory is hosted in STMicroelectronics company industrial site in Tours (France) and allows working in a relaxing but professional environment. Thanks to its integration into the CERTeM technological platform, access to cutting-edge equipment is guaranteed.

For many years, GREMAN has worked on porous silicon (thin films or particles) applications including electronic component development, biomedical applications or energy-storage devices [1]. In



Cross-sectional views of porous silicon layers ALD coated with TiO_2.

particular, recent work on atomic layer deposited material coating porous silicon has shown promising potential for a new generation of micro-supercapacitors. In this context, in order to improve the integrability of porous silicon based devices, it is possible to synthesize them on 8 inches wafers. However, handling such large substrates is not straightforward and requires an important technological know-how, previously developed by our partner; Silimixt company[2]. Additionally, the internship aims to determine the relevant experimental conditions to functionalize silicon by the mean of ALD alumina (Al_2O_3) layer. Finally, we will perform optical characterization in order to understand their potential for enhanced light-trapping devices and photocatalytic cells.

Objectives

This work is divided into three parts:

- **Getting started with 8 inches etching hood and cell.** Our team masters the procedure leading to porous film synthesis (by electrochemical etching) up to 6 inches wafers. Our team recently acquired an 8 inches etching cell and needs to better understand the system. The intern will be in charge of learning the driving software, involves valves and the reactor's architecture.
- **Conformal coating of porous silicon films.** The intern will be in charge of determining the adapted parameters for the deposition of the Al_2O_3 films on top of high aspect ratio previously prepared porous layers. SEM, EDS and XRD will then allow investigating the quality of the functionalization. The obtained films might then be grinded to form nanoparticles in order to see with this ALD functionalization approach is viable.

- **Study of devices optical properties.** In order to understand if these functional films have a potential as solar fuel chips, optical characterization of the films before and after coating should be evaluated. In other words, we will investigate the light-trapping capabilities of the films, the idea being to maximize it. The choice of alumina as a coating material is motivated by the fact that it should allow to enhance the absorption spectrum of porous silicon by luminescent downshifting mechanism [3].

Profile

The intern must be **undergraduate or graduate level**. Moreover, a background in the fields of **material science and/or electrochemistry** is also highly recommended. The internship will last at least **4 months, could ideally last 6 months,** and could start from February 2022. Net salary is 450€/month and is not taxable. From October 2023, it will be possible to carry on as a PhD candidate working on a fully funded project by the French national research agency (ANR) and in collaboration with Sherbrooke University (Canada).

Contacts

If you are interested in the internship or if you need any further information, please do not hesitate to contact us:

Brice LE BORGNE
Maître de Conférences Université de Tours
GREMAN – Site STMicroelectronics
16 rue Pierre & Marie Curie – BP 7155
37071 TOURS Cedex 2
brice.leborgne@univ-tours.fr

Thomas DEFFORGE
Maître de conférences INSA-CVL
GREMAN – Site STMicroelectronics
thomas.defforge@univ-tours.fr

Gaël GAUTIER
Professeur INSA-CVL
GREMAN – Site STMicroelectronics
gael.gautier@univ-tours.fr

References

[1] https://greman.univ-tours.fr/activities/porous-semi-conductor-546388.kjsp

[2] https://certem.univ-tours.fr/version-francaise/certem/gis-certem/silimixt

[3] https://siser.ac.uk/research/next-generation/luminescent-down-shifting