PhD Position (36 month), starting September 2021

Title: Elaboration of porous polymer membranes for precise localization of porous silicon

Field: Material chemistry, polymer, electrochemistry

Hosting laboratories:
ICMN, 1b, rue de la Férollerie, CS 40059. 45071 Orléans
GREMAN – Site STMicroelectronics, 10 rue Thalès de Milet 37071 Tours
Industrial partner:
SiLiMiXT - c/o STMicroelectronics , 10 rue Thalès de Milet, 37071 Tours

Gross salary: 2135€/month (supplemental wages in option, details on request)

Short summary
This PhD thesis proposal deals with an innovative approach in porous silicon etching. The final objective is to obtain well-controlled pore morphologies using perforated polymer membranes deposited on the silicon wafer surface before porous silicon formation. The ability of this novel method to localize micro or nano-sized pores will be evaluated.

Context and content of the thesis
Porous silicon (PS) is a nanostructured material able to answer to many application requirements in microelectronics or energy storage (e.g. power or RF devices, supercapacitor or battery electrodes…). This nanostructured material is generally formed by electrochemical etching (anodic dissolution) of crystalline silicon wafers in hydrofluoric acid (HF) based electrolytes. According to the substrate doping, the crystalline orientation, the electrolyte composition and the electrochemical etching conditions (applied current, duration, etc…), various morphologies can be achieved. The pore dimensions vary from a few nanometers to several micrometers.

The GREMAN laboratory is internationally recognized for its expertise in the field of PS synthesis. In this project, we propose to implement an innovative process that aims to precisely localize the pore growth at the silicon surface combining electrochemical etching in HF electrolyte and perforated polymer membranes. The latter will be developed by the ICMN laboratory which is specialized in the synthesis of porous polymer membranes with pore size varying from a few nanometers (auto-organized block-polymers) to some microns (phase separation in polymer blends, breath figures). This bottom-up approach can lead to a wide variety of geometries and sizes and could help to produce controlled PS morphology without any photolithography step. This thesis will be also the opportunity to study the etching mechanisms involved in this specific configuration, which strongly differs from a silicon surface-free etching process. In particular, a high resistance against HF corrosion is mandatory therefore the use of fluorated polymers could be relevant. These systems that have not been studied so far in the ICMN will be developed during this thesis.

This work will benefit from the ICMN expertise and all the characterization equipments available in the lab (microscopy, X-ray diffraction…). The part of the work dedicated to the masking materials validation will be performed in the GREMAN lab (film adhesion during etching, resistance to HF…). Finally, once the adequate polymers are identified and the etching conditions optimized (HF concentration, anodization current density…), this process will be applied to relevant applications such as supercapacitor electrodes. Transfer to industrial applications will be also envisioned trough the implication of the company SiLiMiXT, a provider of porous silicon technologies to the market.

Profile of the candidate
We are looking for a candidate with a master degree (or equivalent) having knowledge in material chemistry (including polymer and/or semi-conducting materials) and electrochemistry. Knowledge in microelectronic would be appreciated.
Application: cover letter + CV + list of contacts + recommendation letter (optional)

Contacts:

ICMN: **Christophe SINTUREL**, christophe.sinturel@univ-orleans.fr
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