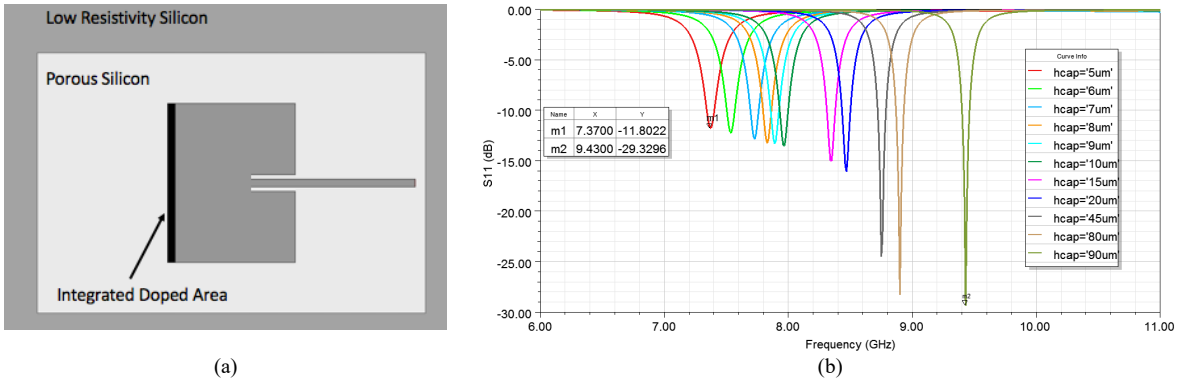
PhD Thesis Proposal

Co-design of reconfigurable microwave components integrated on porous silicon substrates

Abstract:

Whether in the context of 5G or the following standards, future communication systems will have to answer to an ever-increasing demand in terms of number and quality of services. For this, the design of radio-frequency terminals will require a major change in order to offer high-performance microwave components and antennas able to address different norms or standards, while minimizing their impact in terms of energy consumption, dimensions, weight and costs. The use of reconfigurable components and antennas is a solution to these challenges since they make it possible to limit the number of components integrated in the same terminal. Reconfigurable devices can be tunable in terms of resonant frequency, bandwidth or radiation pattern for the antennas (pointing direction, beam width, polarization, etc.). Different solutions for reconfiguring a device or a microwave antenna already exist such as semiconductor components (PIN diodes, varactor, etc.), MEMS or so-called agile materials (ferroelectric, liquid crystals, etc.). However, the interconnection of the active and passive elements causes parasitic effects and a limitation of the rise in frequency related to the size of the soldered active element (i.e. Surface Mounted Devices (SMD)). Finally, this design method is not flexible (linked to the dimensions and location of the active component, need for metallized vias). On the other hand, the transmission lines are designed by optimizing their quality factors i.e. their losses while the deferred active elements are optimized in size. The result of their association is a device that has a low quality factor linked to the losses of the tuning element and a large size linked to the footprint of the passive part.

The feasibility of co-designing tunable microwave devices such as filters or antennas has already been demonstrated in [1]–[8] where the idea is to design the microwave components on a semiconductor substrate such as silicon and to size and position doped zones in a judicious way in order to modify the behavior of the component and thus make it the tunable passive component. This solution, recently developed at Lab-STICC in Brest, offers great flexibility and a simplified design of reconfigurable circuits, performance optimization and ease of integration. However, the high permittivity of the silicon substrate is not optimal for antenna performance. Thus, we propose in this project to explore a new technology such as porous silicon which allows both to decrease the permittivity and the losses of the substrate [9]–[11]. Figure 1 shows an example of a porous silicon antenna using a doped area with variable capacitance allowing tuning of the operating frequency of the antenna.



(a) (b)

Fig. 1. (a) Patch Antenna designed on a porous silicon substrate. (b) Simulated results of the antenna depending of the bias voltage of the active element.

Thesis Description:
Thesis: Co-design of tunable microwave devices integrated on porous silicon

The doctoral student will rely on the knowledge developed at Lab-STICC (http://www.lab-sticc.fr) in terms of co-design method based on a co-simulation between two commercial software allowing to describe both the transport of charges in semiconductor junctions (Silvaco) and the effects of propagation of electromagnetic waves (HFSS). This thesis will focus on tunable antennas on porous silicon going towards the system aspect and integration of several functions of the RF front-end. A state-of-the art on tunable components, tuning solutions and semiconductor components will be carried out. Then, once the properties of porous silicon have been mastered, different junctions will be studied in order to propose innovative topologies of integrated tunable antennas and then of several elements of the RF front-end within the same chip.

The demonstrators will be made at the laboratory GREMAN at the university of TOURS. From the proposed co-design method, tunable devices (such as switches, multi-state tunable resonators, bandwidth or frequency tunable filters, as well as frequency tunable antennas) have already been realized. They made it possible to show the flexibility of design based on a controlled process and high precision, offering the possibility of moving towards high-frequency demonstrators. Thus, the proposed thesis is the logical continuation of this work which will make it possible to increase the performance of antennas thanks to porous silicon and to go further towards the co-design no longer of components but of functions or even subsystems such as shown in Figure 2 where we can see a tunable antenna network designed on porous silicon associated with a switch and filters on high-resistivity silicon.

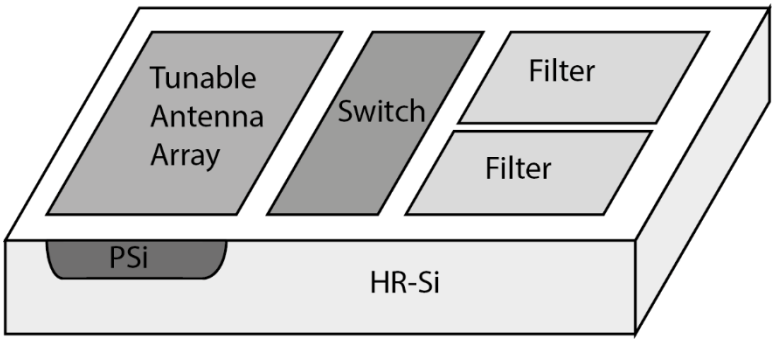


Fig. 2. Part of a RF Front-end designed on a silicon substrate

Keywords: Antenna, Filter, Reconfigurable, RF switches, porous silicon, semiconductor physics, tunable.

Supervisors: Rozenn Allanic, Denis Le Berre, Cédric Quendo

Candidate Profile - Master Degree or equivalent
- European Union citizenship

Skills : Semiconductor physics (PIN diodes, Varactor diodes), Simulation and Modelization of microwave devices, Measurement (oscilloscope, network analyzer), Silvaco, HFSS, Comsol Multiphysics.

How to apply? Send a CV and motivation letter before April 12, 2023 by e-mail to Rozenn.Allanic@univ-brest.fr

Starting Date: Around October 2023

Références :

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