SUP MICRO TECH ENSMM
ECOLE NATIONALE SUPERIEURE DE MECANIQUE ET DES MICROTECHNIQUES

UBFC
UNIVERSITÉ BOURGOGNE FRANCHE-COMTÉ

école doctorale **sciences pour l'ingénieur et microtechniques** SPIM

Thesis title: Design, characterization and packaging of 5G microwave piezoelectric resonators

Host Laboratory: Institut FEMTO-ST, département Temps-Fréquence, CNRS UMR6174, 26 rue de l'épitaphe 25000 Besançon, inside ENSMM building

Speciality: Engineering Sciences and Microtechnics

Keywords: 5G, resonators, surface acoustic waves, electromagnetism, electromagnetic compatibility, waveguide,

Job description:

Applications such as precise localization/altimetry, navigation and time scale protocols increasingly require very high frequency stability and spectral purity, provided by ultra-stable resonators and oscillators (USO) at high frequencies (1-6 GHz). A new design of high frequency elastic wave resonators has been recently developed using piezoelectric thin film growth by epitaxy at FEMTO-ST [1]. Association of different substrates (sapphire, quartz, Si, SiO_2 ...) and $LiNbO_3$ piezoelectric thin films allows optimizing the performances in terms of frequency stability, temperature drifts and gives frequency spectral ranges up to 6 GHz. Characterization of this kind of resonator could be done in terms of phase noise using measurement benches with state-of-the-art performance levels.

The objective of the PhD will focus on the design and measurement of this new range of resonators on hybrid substrates. The candidate will focus on simulating the performance of interdigitated comb micro-acoustic components up to 6 GHz, characterizing the fabricated resonators, and finally PhD student will focus on the final integration of the components on PCBs and in packages. The student will use and improve noise measurement benches for passive resonators in the 1 to 6 GHz range [2], [3].

Thesis topics:

After a bibliography on elastic wave resonator technologies, the candidate will take over the COMSOL software for 2D and 3D simulation of micro-acoustic components. In collaboration with the microfabrication team, he will simulate and optimize the performance of LiNbO3 resonators on different substrates. A second part of his work will focus on simulating the impedance matching on ADS and the electromagnetic radiation on HFSS to end up with the packaging of the components. The components will then be tested in terms of temperature and noise. The study will allow the characterization of elastic wave devices and will focus on the origin of the measured noise.

The candidate will have to ensure a strong interaction with the microfabrication team and more broadly with our collaborators in order to have access to state-of-the-art resonators from various sources (EPFL [4]) as well as to carry out work on radio frequency packaging with national actors in the 1-6 GHz domain.

Bibliography

[1] A. Almirall et al., High-frequency surface acoustic wave devices based on epitaxial Z-$LiNbO_3$ layers on sapphire Appl. Phys. Lett. 114, 162905 (2019).

[2] E. Vaillant et al., Phase noise measurements of AlN Contour-mode resonators with carrier Suppression Technique, IEEE Transactions UFTS 65 (10), 1943, 2018

[3] A. Pokharel et al., Carrier suppression system to measure phase noise of acoustic resonators with low motional resistance, Review of Scientific Instruments 91 (8), 085104 2020.

[4] P. Sadeghi et al., Frequency fluctuations in nanomechanical silicon nitride string resonators, Phys. Rev. B 102, 214106 (2020).

Applicant profile

School Engineer or Master 2 Student, the candidate must have an interest in simulation and computer design of finite element methods and high frequency electronic components.

Preferred selection criteria:
- Scientific Skills

- Motivation

Personal characteristics:
- Serious
- Method, organization
- Punctuality

Financial Source: MESRI Etablissement

Apply as soon as possible
Starting date: 1st October 2022
Month Salary: 1975 €

Thesis Supervisor
STHAL Fabrice, fsthal@ens2m.fr ;

Co-supervisor
IMBAUD Joël, joel.imbaud@ens2m.fr

Applicants are invited to submit their application to the PhD supervisors.
Application must contain the following documents (**in English or French**):
- CV
- Cover letter
- At least 1 reference letter