ULTRASENS-E

All-dielectric and ULTRASENSitive microwave Electric fields sensor based on the electro-optic effect

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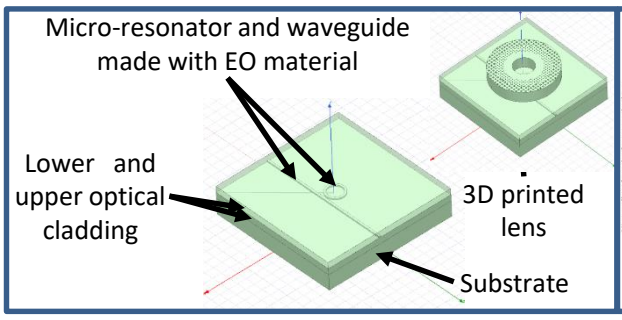
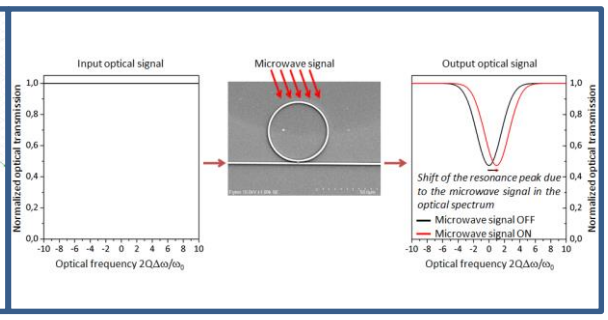
Abstract

We propose to increase the sensitivity of microwave electric field sensors by two orders of magnitude. To do this, we will combine a lens made by 3D printing focusing the wave on a photonic micro-resonator made with a very efficient electro-optical (EO) polymer. These improvements will be of great benefit to all areas of microwave radiation applications: for example, life sciences or electronics industry.

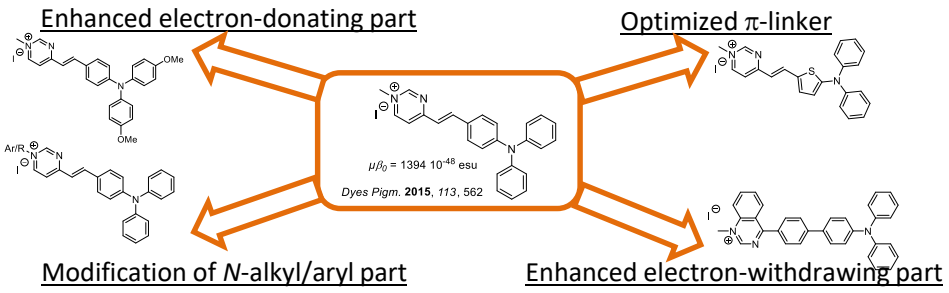




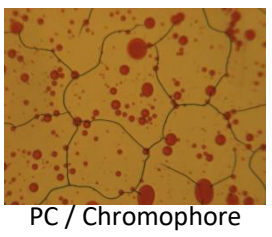
The long-term objective is to approach an integration close to that of a commercial probe (e.g. the Kapteos probe shown below)

The past two year's achievements: KEY STEPS

☺ Choose a good chromophore (dye) and synthesize it in sufficient quantity (a few grams)
Various structural modifications have been proposed to improve the NLO response of N-methylated styrylpyrimidinium.

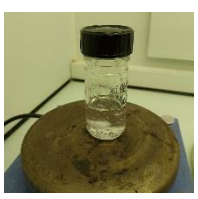


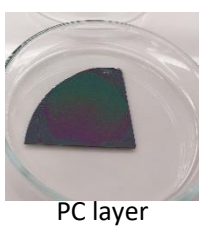
☹ Integration, orientation of these chromophores in a host matrix and obtaining sufficient electro-optical coefficients
- Choice of a new matrix (high Tg polymers : PC instead of PMMA / Relative Temperature Index (Mechanical without impact) = 150°C)
- The tests didn't produce a films of sufficient quality to make the EO measurements.

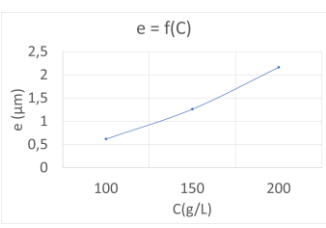

PC / Chromophore


Ellipsometer for EO effect measurement

😐 Shaping of these new materials
Optimization of the pristine matrix, and PC matrix / chromophore deposition (choice of the good solvent and deposition parameters)

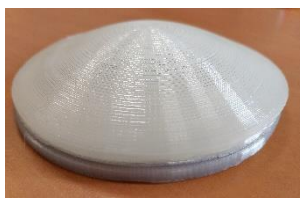

PC / TCE solution


PC layer

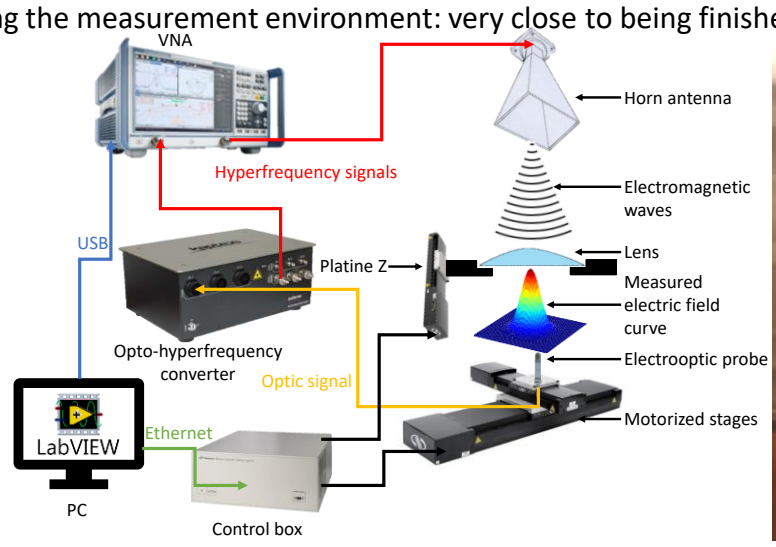


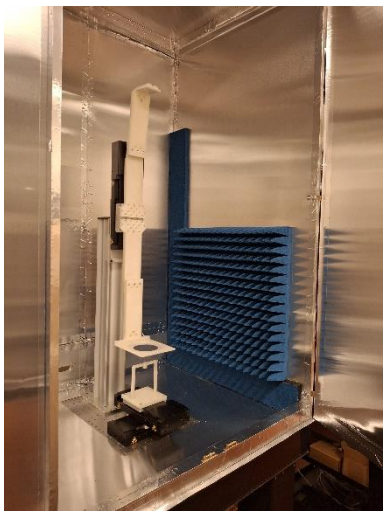
☺ Design and realization of the micro-resonator: *No insurmountable problem for this stage provided a stable material is available beforehand*

☺ Design and production of the lens by 3D printing


Lens with adaptation layers
Gain: 14,2dB
Preperm™ ABS1000 / PLA

☺ Microwave measurement bench automation:
- 10-week IUT internship funded by the SMART team of Lab-STICC
- Improving the measurement environment: very close to being finished





😐 Assembly of the whole: *Too early to judge*

Main hard point: Choice of new material ($LiNbO_3$, III-V) ?

Publications:

- C. Vong, A. Maalouf, V. Laur et A. Martin-Guennou, “Etude de lentilles hyperfréquences et cartographie du champ électrique en champ proche”, JCMM, Tours, 3-5 Avril 2023.
- C. Vong, A. Maalouf, A. Martin-Guennou, V. Laur, P. Laurent, “Optimisation d’une lentille de Fresnel entièrement diélectrique pour des applications micro-ondes en champ proche”, JNM, 5-7 juin 2024 – Antibes Juan-Les-Pins
- T. Bonnaud, M. Scaviner, F. Robin-le Guen, S. Achelle, “4-substituted push-pull quinazoline chromophores with extended π-conjugated linker”, J Heterocyclic Chem. 2024;61:358–364.
- A publication on lenses is currently being drafted and will be published in a peer-reviewed international journal.