Postdoctoral project
18 months, renewable 1 time

Crystalline oxide growth for silicon photonics

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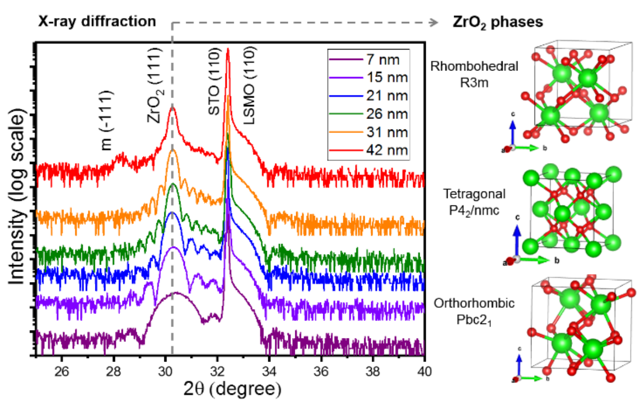
Scientific description

Silicon photonics, i.e. the use of Si for integrated circuits, has emerged industrially more than a decade ago and is now a well-established technology. For future communication networks, new challenges have to be considered in terms of speed, power consumption, flexibility, and reliability. At C2N, we are currently exploring a new paradigm for advanced photonic circuits based on the hybrid integration of crystalline oxides in the silicon photonics platform for the telecom wavelength range (1.3µm-1.55µm). This will provide several physical properties non-existent in Si, in particular strong nonlinearities, ferroelectricity and light amplification, thus enabling advanced nonlinear and optoelectronic devices.



This project will explore the properties of doped oxide thin films, focusing on zirconia (ZrO_2) as oxide matrix, having obtained first results in terms of light amplification and nonlinear effects with this promising material [1,2]. The growth will be done by molecular beam epitaxy (MBE) with metalorganic (MO) precursors, in particular Zirconium(IV) tert-butoxide as Zr source. MO-MBE will allow for the fine tuning of the dopant concentration, the control of the oxygen stoichiometry, and chemically sharp interfaces for the growth of multilayers. The team also has a strong expertise in the growth of zirconia-based thin films by pulsed laser deposition (PLD). A key challenge of the project is to stabilize a ferroelectric phase of doped ZrO_2 at 50 nm thickness or more, in order to exploit its nonlinear optical properties for photonic applications [3]. Stimulating results have already been obtained in this respect at C2N with PLD-grown zirconia films [4,5], paving the way for the study of dopant- and strain-engineering.

All the experimental facilities for the project are available in C2N cleanroom, together with the tools for structural, optical, and electrical characterizations of the samples in dedicated labs.

The work is part of the ERC Advanced Grant CRYPTONIT on doped crystalline oxides for silicon photonics.

References

[1] G. Marcaud *et al*., Photonics Research (2020).
[2] A. Ruiz-Caridad *et al*., IEEE J. Select. Topics Quant. Electronics (2021).
[3] A. El Boutaybi *et al*., Phys. Rev. B (2023).
[4] A. El Boutaybi *et al*., Phys. Rev. Materials (2022).
[5] A. El Boutaybi *et al*., J. Mat. Chem. C (2023).

Applicant profile: Gifted for experimental physics, well-disposed towards non-centrosymmetric crystalline unit cells, with a background in materials science and/or solid state physics. Prior experience in oxide epitaxy by MBE or PLD is very welcome.