

Thesis title

Enhanced-transmission metamaterial-based acousto-optical modulator: design, fabrication and characterization

Description The goal of this thesis is to numerically simulate, manufacture by nanotechnology processes, and experimentally characterize an original structure acting as an acousto-optical modulator of nanometric size. The general principle of operation is based on the coupling between a mechanical resonance (vibration mode) of a metallic grating deposited on a piezoelectric material and the light transmission through the same grating. Theoretically, this coupling could lead to very efficient light modulation if the operation wavelength corresponds to a large Q-factor resonance mode. The grating is then designed to exhibit such resonance. Numerical tools are already developed based on FDTD algorithms [1] but must be adapted to study the optical response of real structures taking into account manufacturing errors (edge conicity, finite size of the structure, roughness, etc.). An ideal geometry of the structure was already studied and published [2] showing high modulation performances. An important part of the thesis will be devoted to the development of technological processes for the most faithful fabrication in the clean room (Mimento) of FEMTO-ST. Optical and acoustic characterizations will validate the performances of the final device after building suitable acousto-optical measurement benches.

[1] BELKHIR, A. and F. I. BAIDA, "Three-dimensional finite-difference time-domain algorithm for oblique incidence with adaptation of perfectly matched layers and nonuniform meshing: Application to the study of a radar dome". Phys. Rev. E., 77, 056701 (2008).

[2] V. Laude, A. Belkhir, A. Alabiad, M. Addouche, S. Benchabane Gaiffe, A. Khelif and F. Baida « Extraordinary nonlinear transmission modulation in a doubly resonant acousto-optical structure », Optica, 4, 10, 1245 (2017).

Keywords Nanotechnology, metamaterials, modulators, acousto-optic, numerical simulations, experiments.

Title of doctorate Ph.D. in Optics and Photonics

Establishment delivering the doctorate UFC, Université de Franche-Comté, Besançon, France

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Candidate profile Applicants must be highly motivated and interested in the subject. They must be organized and able to work collaboratively, both with other team members and with external collaborators. The candidate should have a solid theoretical background in electromagnetism, basic knowledge in numerical simulation, and a real will for the work in clean room and for the experiment in optics. The candidate must have an average M2 mark of 13 or more in an appropriate physics discipline to be competitive for the doctoral school (ED SPIM) application. For candidates outside the French system, the equivalent of a "B" or more is required.

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Duration 3 years

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