Offre de stage Master 2

This project is a joint research collaboration between two laboratories: CIMAP and Institut FOTON.

Internship topic: Bipolarization emission of visible solid-state lasers

Currently, there is a great demand for compact, efficient, single-mode and linearly polarized laser sources directly emitting visible light at various colors. They find applications in high-resolution microscopy, flow cytometry, ophthalmology, etc. Due to the recent progress in the technology of blue semiconductor GaN-based laser diodes enabling direct pumping of rare-earth doped crystals, direct emission of visible light from diode-pumped solid-state lasers was enabled [1]. Among the laser crystals giving rise to visible emission, praseodymium (Pr) doped optically uniaxial $LiYF_4$ crystals occupy a special place due to their efficient lasing in the blue, orange, red and deep-red [2].

The polarization behavior of blue diode-pumped Pr:$LiYF_4$ lasers still needs to be understood, especially when the crystals are cut along the optical axis not favoring any specific polarization state to oscillate in the cavity. Dual-polarization visible Pr lasers could constitute a unique tool for bio-medical applications by enhancing the information acquired during their use. During the proposed internship, we aim at understanding the polarization behavior of visible (orange, red, deep-red) Pr lasers using crystals cut along and orthogonal the optical axis, as well as correlating it with the material birefringence and anisotropic thermal lensing.

The internship will include two parts: the first part, at the Institut FOTON in Rennes, will be devoted to get experience on dual-polarization lasers, with emphasis on an Yb-doped $LiYF_4$ crystal emitting in the infrared. Ytterbium-doped isotropic crystals have already been shown to emit two orthogonal polarization states [3]. The objective is to make a full characterization (optical and RF spectra, polarization states, intensity noise) with this c-cut $LiYF_4$. In the second part, these studies and results will be extended at CIMAP to visible lasers using the same crystal doped with praseodymium.

Applicant: Master Optique/Photonique/Laser or Engineering school.

Références

[1] C. Kränkel, D. T. Marzahl, F. Moglia, G. Huber, and P. W. Metz, "Out of the blue: semiconductor laser pumped visible rare-earth doped lasers," Laser Photon. Rev. **10**(4), 548-568 (2016).
[2] W. Bolaños, G. Brasse, F. Starecki, A. Braud, J.-L. Doualan, R. Moncorgé, and P. Camy, "Green, orange, and red Pr^{3+}:$YLiF_4$ epitaxial waveguide lasers," Opt. Lett. **39**(15), 4450-4453 (2014).
[3] H. Akagla, N. Chapron, G. Loas, M. Vallet, and M. Brunel, "Control of the bipolarization emission of an Yb:YAG laser by the orientation of the pump polarization," Opt. Lett. **48**, 700-704 (2023).

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CIMAP *is located in Caen, Normandy. The team OML (Optics, Materials and Lasers)) is known for its excellence in developing novel laser materials and solid-state lasers, including those emitting in the visible. Over the past decade, the OML team has been leading the research on fluoride laser crystals. The OML team has a joint lab (LabCom) with the Oxxius company developing visible lasers.*

The DOP team of ***Institut FOTON****, located in Rennes, works on a wide range of photonic topics, including low-noise lasers, terahertz metrology, dual-frequency lasers, optoelectronic oscillators, interferometric sensors, lidar, frequency combs, fiber sensors and optical antenna control. The team includes a multi-skilled technical platform (optics, electronics, mechanics, IT) to design and build original systems.*