Ph.D. scholarship in Efficient mid-IR supercontinuum generation in quadratic nonlinear waveguides

A 3 year Ph.D. position is available in the Department of Photonics, Technical University of Denmark (DTU). The Ph.D. project is a part of the Marie Skłodowska Curie Initial Training Network SUPUVIR (SUPercontinuum broadband light sources covering UV to IR applications), which is a European PhD school that commences on October 1, 2016. It combines the efforts of 6 academic and 4 non-academic partners across Europe, and 15 new Ph.D. positions (5 in Denmark) are now open. Additionally the network launches a comprehensive international training program within the technology of supercontinuum laser sources at leading photonics research labs across Europe.

Project description

The goal of this specific project is to investigate mid-IR supercontinuum generation by exploiting negative nonlinearity solitons ("negatons") in waveguides in quadratic nonlinear mid-IR transparent crystals, especially lithium niobate (LN). Negatons are solitons that form in the normal dispersion regime, making the waveguide dispersion requirement obsolete as the normal dispersion regimes of mid-IR materials overlap with near-IR laser wavelengths. In LN crystals the ZDW is close to 2 µm, so the negaton can be excited directly by near-IR lasers. Moreover, the supercontinuum has a mid-IR part is formed by dispersive waves phase-matched to the negatons. The goal is both to investigate without and with quasi-phase matching (QPM). While QPM is standard for LN, it has not yet been implemented in other mid-IR crystals. A QPM-free design allows exploring ridge waveguides in practically any mid-IR crystal. QPM in turn offers tunable control over spectral resonances, enhancing the UV-visible and mid-IR SC, and also has in lower requirements to peak power. The first goal is to design waveguides will be designed by and fabricated through external collaborators of DTU: custom-made buried LN waveguides are supplied by prof. Y.-H. Chen, National Central University, Taiwan; ridge waveguides by prof. D. Kip, Helmut-Schmidt University, Hamburg, Germany, using the diamond-saw dicing technique or with diced "micro-rods" of crystals that then can be adhered to a low-index substrate. This generic approach solves the problem for mid-IR crystals where wafer bonding could be an obstacle. QPM of the fabricated LN waveguides can be done either at Taiwan or at the group of prof. K. Gallo, KTH, Sweden. The second goal is to test the waveguides with femtosecond laser pumping for supercontinuum generation. An overall objective is to use waveguides designed for broadband mid-IR guidance and generate a high-power mid-IR supercontinuum (up to 5.5 µm).

The candidate will work closely with the other SUPUVIR candidates, especially the 4 other Danish-based students. Secondmendts at the Danish company NKT Photonics and at the French company LEUKOS are planned, and also shorter or longer trips to Germany, Taiwan or Sweden will be necessary to complete the waveguide fabrication.

Background to SUPUVIR

The initial training network SUPUVIR involves 15 Ph.D. positions within the broad field of supercontinuum sources, which essentially are laser sources emitting coherent laser light that is broadband enough to be considered white. Scientifically, SUPUVIR aims at solving current challenges preventing supercontinuum light sources from taking over key market shares or from being used for cutting-edge research. Specifically the objectives are to reduce noise and increase pulse energy of supercontinuum modules, as well as investigate supercontinuum generation in emerging wavelength regimes (UV and mid-IR) including fabrication of novel fibres and waveguides, and finally using supercontinuum sources for applications as to gain valuable knowledge of application requirements. This research and development will give improved supercontinuum sources and supercontinuum spectra enabling new science and applications for optical

imaging, spectroscopy, sensing and control, e.g. optical coherence tomography, IR multimodal spectroscopy, confocal and fluorescence microscopy, photoacoustic imaging and food quality control.

Supercontinuum sources is an area where Europe has developed internationally competitive research and commercial activity. SUPUVIR will exploit new emerging opportunities brought forward by the supercontinuum source through its unique properties of delivering a stable, bright, broadband and coherent light beam. SUPUVIR will provide the co-evolution of technology and applications, and hence contribute to the strategic transition of Europe to a knowledge-based society, driving the transformation of industry towards higher added value and sustainable development.

SUPUVIR involves interdisciplinary research, blending nonlinear physics, applied mathematics, numerical modelling, fibre optics, material science, laser physics, as well as intersectoral applications in diverse scientific areas like physics, material science, chemistry, and bio-medicine and in the industrial sector for applications like production line monitoring, gas sensing, imaging etc. The knowledge and experience in these complementary disciplines are present in the consortium, and will contribute to significant advancements in the field.

Qualifications

Candidates are required to have a Master's degree or very good first degree in Physics, Engineering or Material Science, ideally with a track record within the areas of nonlinear optics, fibre optics and waveguides, and laser physics. At the time of recruitment by the host organization, candidates must be in the first four years (full-time equivalent research experience) of their research careers, and have not been awarded a doctoral degree.

Researchers can be of any nationality. They are required to undertake transnational mobility (i.e. move from one country to another) when taking up their appointment. Nationality is therefore not a criterion. Rather the location of the researcher's residence or main activity during the 3 years prior to their recruitment is determining. At the time of recruitment by the host organisation, researchers must not have resided or carried out their main activity (work, studies, etc.) in the country of their host organisation for more than 12 months in the 3 years immediately before the reference date. Compulsory national service and/or short stays such as holidays are not taken into account.

Approval and Enrolment

The scholarship for the PhD degree are subject to academic approval, and the candidates will be enrolled in one of the general degree programs of DTU. For information about the general requirements for enrolment and the general planning of the scholarship studies, please see the DTU PhD Guide. You can read more about Department of Photonics Engineering on www.fotonik.dtu.dk

Salary and appointment terms

Salary and appointment terms are consistent with the current rules for PhD degree students. The PhD candidate will be employed on a 3 year contract at a salary equivalent to €50,494 per year supplemented by a monthly mobility allowance of €1,100 (candidates with family responsibilities) or €600 (candidates without family responsibilities).

Further information

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