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Mid-infrared sources, based on chalcogenide glass fibers

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Mid-infrared (MIR) direct fiber lasers beyond 4 µm wavelength will deliver optimum beam quality of bright, spatially and temporally coherent light, routeable in MIR fiber-optics. They are being developed for applications including narrow-band biomolecular sensing, medical laser surgery at new, long wavelengths and for pulsed seeding of long-wavelength MIR- supercontinua in MIR glass fiber for all-fiber, compact systems for broad-band MIR medical sensing and hyperspectral imaging. Low phonon energy, selenide chalcogenide glasses are the optimum glass host for lanthanide ion doping for emission across the 3 to 10 µm wavelength MIR region. Here, we report our recent advances including: > 1 mW incoherent emission in the 4-5 µm wavelength region; demonstration of gain beyond 4 µm in Pr^{3+} doped chalcogenide glass fiber, and proposed quasi three-level lasing beyond 4 µm in Tb^{3+} doped chalcogenide glass fibers. Encouragingly, since 2020, lasing in both Pr^{3+} and Tb^{3+} selenide chalcogenide bulk glasses has been reported. Our overall goal is for new portable, MIR spectroscopic systems based on chalcogenide optical fibers for in vivo sensing, imaging and treatment in healthcare, including for early diagnosis of disease.

Keywords: Mid-infrared, fiber lasers, lanthanide ion doping, bulk glass lasers, chalcogenide glasses.

Biography

I lead the Mid-Infrared Photonics Group at the University of Nottingham, UK. My vision is to bring about a new paradigm in mid-infrared (MIR) biophotonics for portable, real-time, sensing and imaging in medicine based on new MIR fibreoptics, including for real-time, in vivo cancer diagnosis. I run a world-class suite of labs. dedicated to the synthesis and characterisation of long-wavelength mid-infrared optical fibres and devices. My seminal 1995 paper cited 591x rekindled interest in MIR chalcogenide-glass photonics. The Royal Academy of Engineering / Leverhulme Trust Senior Research Fellowship (2007 / 08) & Medical Research Council, Discipline Hopping Fellowship (2008 / 09) were awarded to initiate my MIR biophotonics' research. My Optics Express review re-set some ground rules for achieving MIR fibre lasingcited 274x. With DTU, Denmark, we set a world record (held for 6 months) in 2014 in broadband MIR sources demonstrating a MIR-supercontinuum spanning 1.4 µm to 13.3 µm spectral range in fibrecited 745x.This was the first experimental demonstration truly to reveal the potential of MIR fibres to emit across the MIR molecular "fingerprint spectral region" and a key first step towards bright, portable, broadband MIR sources for biomolecular sensing, including for cancer detection. I am elected Fellow of SPIE for special contribution to glass photonics, Fellow of the Society of Glass Technology, Fellow of the Institute of Materials, Minerals and Mining and Fellow of the Royal Society of Chemistry. 269 publications, 238 talks at conferences and institutions, including 100 invited.

SESSION SPEAKER