FIBER BASED MID INFRARED SUPERCONTINUUM SOURCE FOR SPECTROSCOPIC ANALYSIS IN FOOD PRODUCTION

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Introduction

Optimization of sustainable food production is a worldwide challenge that is undergoing continuous development as new technologies emerge. Applying solutions for food analysis with novel bright and broad mid-infrared (MIR) light sources has the potential to meet the increasing demands for food quality and production optimization. By combining a new MIR supercontinuum source with spectroscopy and chemometrics, we seek to enable faster and more precise analysis of grains, soils and dairy products.

Light Source

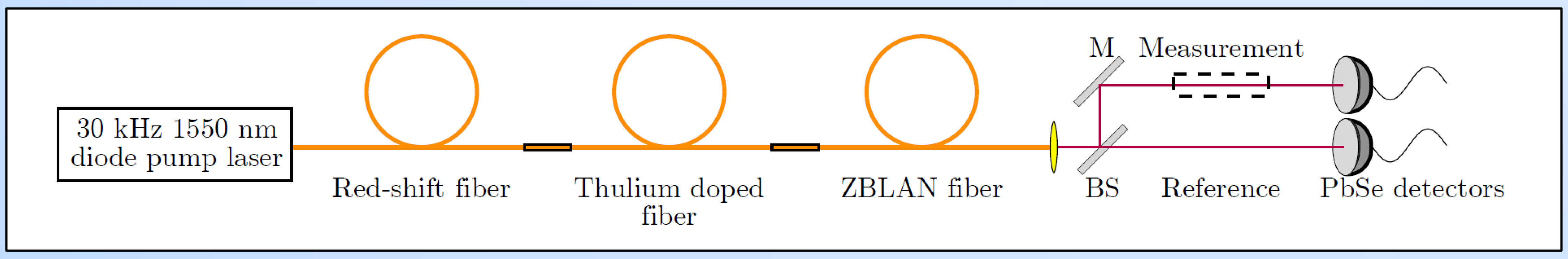

Fig 1: Supercontinuum setup for spectroscopic analysis in the MIR region

The source is based on supercontinuum generation in a ZBLAN fluoride step-index fiber. This fiber is chosen owing to the transparency in the wavelength region from 400 nm to ~4500 nm. The dispersion characteristics of ZBLAN are important for the generation process, and in order to enable soliton dynamics in the fiber, the pump laser must be in the anomalous dispersion regime. Therefore, a 1550 nm pulsed diode seed laser with a tunable repetition rate of 30-100 kHz is used, followed by a red-shifting single-mode fiber, reaching a pulse wavelength of 1900 nm, beyond which the dispersion of ZBLAN is anomalous [1]. A thulium doped fiber amplifier amplifies the pulse before entering the ZBLAN fiber. Here, the supercontinuum is generated, and the spectrum is broadened significantly. The spectral broadening effect is due to a combination of linear and nonlinear interactions in the ZBLAN fiber. The resulting spectrum is seen in Fig. 2, and covers the wavelength region from 2.5-4 μm, where vibrational absorption bands from water and fatty acids are found.

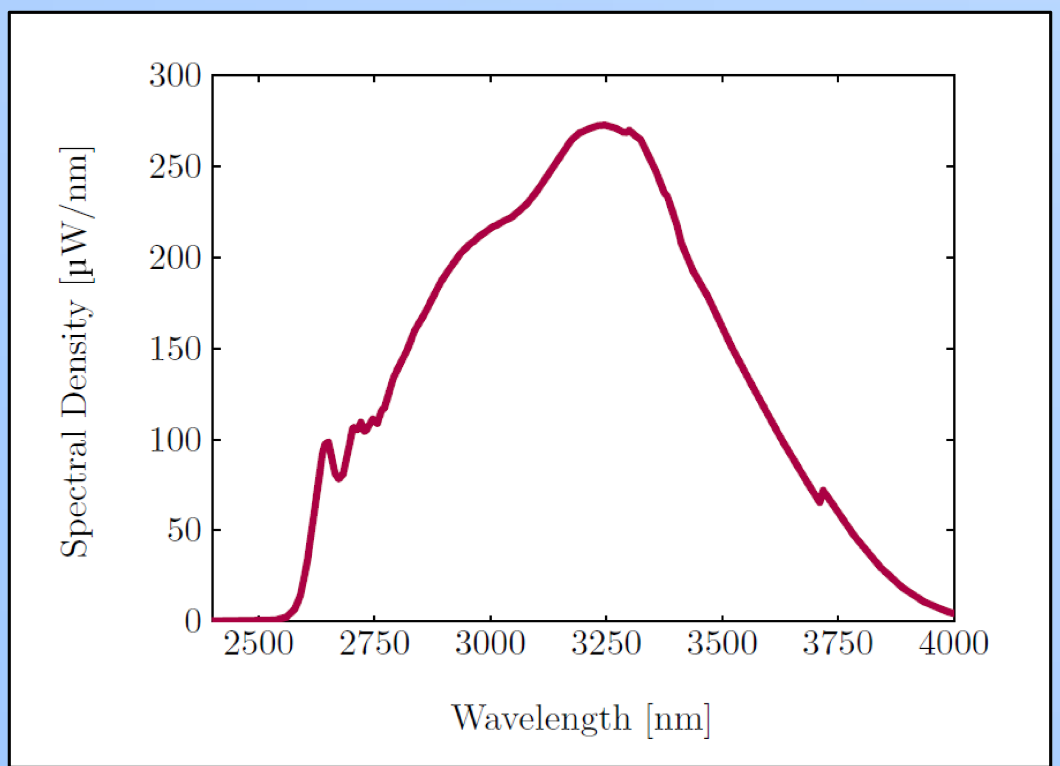

Fig. 2: Supercontinuum spectrum in the MIR region from the ZBLAN fiber output.

Each pulse is measured and normalized to a reference by using two equivalent PbSe detectors and an oscilloscope. By using appropriate filters and wavelength selection, spectroscopic analysis can be performed in a single shot. Since the source is all-fiber based, the system is very compact and robust, suitable for harsh environments. Combined with high spectral density and spatial coherence, the source is optimal for in-line fast spectroscopic analysis for industries.

Future

Supercontinuum generation in soft glass fibers is inherently noisy, as it is seeded from stochastic processes. Therefore, noise reduction schemes such as pulse-to-pulse normalization is required to lower detection limits, and still presents a challenge due to inefficient and slow detection in the infrared region. Furthermore, setups for remote sensing requires sophisticated engineering, and development of these techniques are crucial to access the full advantages of the source. Recent analysis of supercontinuum generation and noise properties of this type of source can be found in references [1-2].

Collaborators

The Danish National Advanced Technology Foundation

NKT Photonics the power of light

FOSS

Technical University of Denmark DTU

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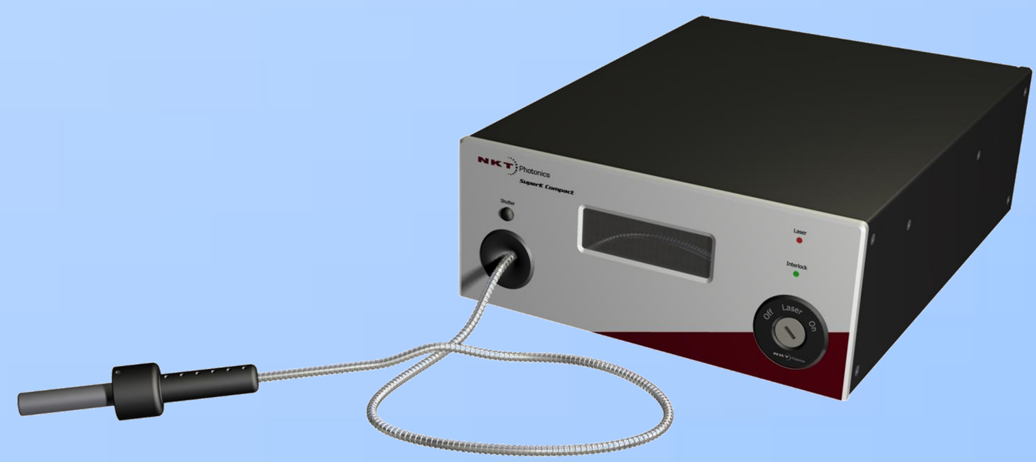

References

1. Ramsay *et al.*, Opt. Express / Vol. 21, No. 9 / April 2013
2. Dupont *et. al.*, J. Opt. Soc. Am. B/ Vol. 30, No. 10 / October 2013

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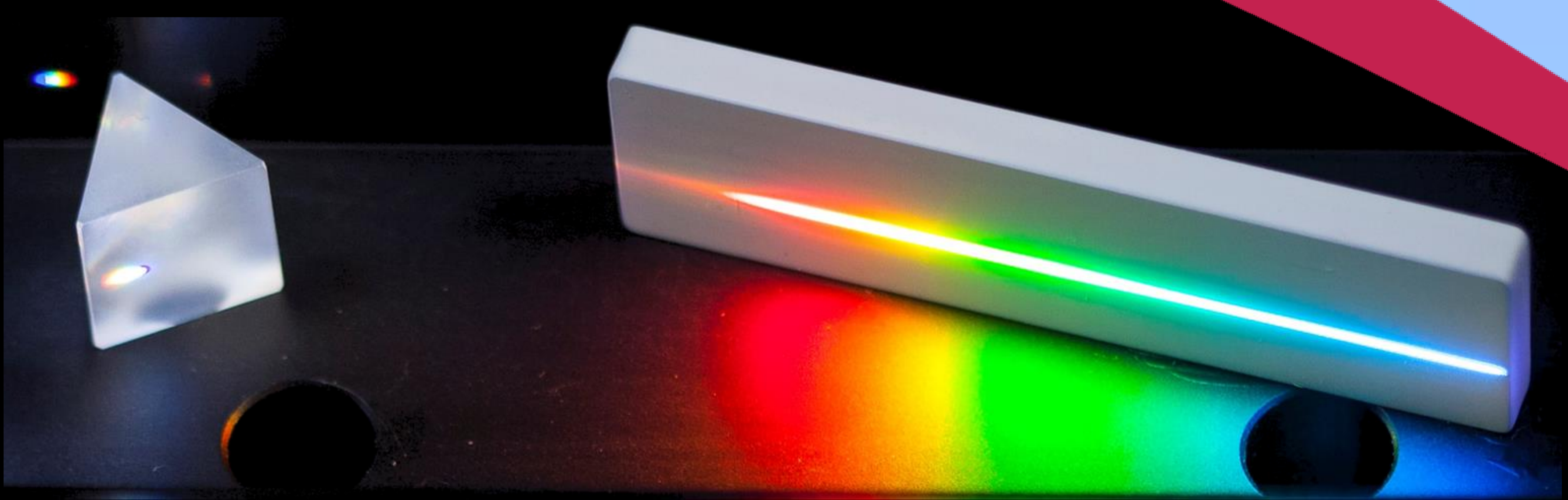

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