LATVIJAS UNIVERSITĀTE

FOTONIKA-LV

LATVIJAS UNIVERISTĀTES NACIONĀLĀ ZINĀTNES PLATFORMA

The 5th International Conference

Quantum sciences, Space sciences and Technologies – PHOTONICS RIGA 2023

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BOOK OF ABSTRACTS

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Contents

SHORT PRESENTATIONS

POSTER PRESENTATIONS

Keynote speeches

Decade of Quantum Optics laboratory

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Laboratory of Quantum Optics was established a decade ago in 2013 during the FOTONIKA-LV project[1], acquiring a femtosecond optical frequency comb metrology laser, tuneable diode lasers, rubidium saturation spectrometer and laser stabilisation resonators. Afterwards, the laboratory won three research projects on optical whispering gallery mode microresonators (WGM). WGM resonators confine and circulate light within a circular cavity, offering high sensitivity to changes in the surrounding environment. Due to their low optical losses, high quality factor (Q-factor), and excellent thermal stability, silica microsphere resonators are particularly suitable for frequency comb generation. Below is a summary of the Quantum Optics laboratory's publications in the last 5 years grouped in two categories: sensing applications and microresonator frequency combs.

Whispering gallery mode resonator and glucose oxidase based glucose biosensor

This paper discusses the development of a novel glucose biosensor that uses whispering gallery mode (WGM) resonators and glucose oxidase (GO_x) enzyme [1]. The research aims to provide a more sensitive, selective, and reliable method for glucose detection, which is crucial for diabetes management.

Whispering gallery mode resonators coated with Au nanoparticles

The deposition of Au nanoparticles onto WGM resonators can enhance their performance by introducing new properties, such as localised surface plasmon resonance (LSPR) to exploit the enhanced properties for light-matter interactions [2].

Whispering gallery mode resonators covered by a ZnO nanolayer

The paper presents a comprehensive investigation of the properties of ZnO nanolayer-covered WGM resonators, including their fabrication process, the influence of the nanolayer thickness, and the resulting changes in the resonator's performance [3]. The study also discusses the potential applications of these modified resonators in various fields, such as sensing and optoelectronics.

Computer modelling of WGM microresonators with a zinc oxide nanolayer using COMSOL multiphysics software

The addition of a ZnO nanolayer to the silica surface can enhance the performance of WGM resonators, as ZnO is known for its unique optical, electrical, and piezoelectric properties. The paper [4] describes the computer modelling process using COMSOL Multiphysics software, which enables the simulation and analysis of various physical phenomena in WGM resonators with a ZnO nanolayer. This approach allows for a comprehensive investigation of the effects of the ZnO nanolayer on the resonator's performance, including factors such as mode profiles, mode coupling, and quality factor (Q-factor).

[1] https://cordis.europa.eu/project/id/285912

Whispering gallery mode resonator temperature compensation and refractive index sensing in glucose droplets

This paper [5] presents a temperature compensation technique for WGM resonators, by coating silica microsphere with a thin layer of PMMA that has an opposite sign of thermo-refractive coefficient. Second part explores drying of glucose droplets where refractive index increases in time.

High-sensitivity whispering gallery mode humidity sensor based on glycerol microdroplet volumetric expansion

High-sensitivity whispering gallery mode (WGM) humidity sensor is demonstrated [6]. Glycerol is a hygroscopic substance, meaning it readily absorbs moisture from the environment, causing its volume to expand or contract depending on humidity levels. Expansion results in shifts in the resonant frequency of the WGM resonator.

Selectivity of glycerol droplet microresonator humidity sensor

In this paper [7], researchers investigate the selectivity of a glycerol droplet microresonator humidity sensor. Humidity sensors are essential for various applications, such as environmental monitoring, industrial processes, and biomedical devices. Glycerol droplet microresonators, a type of whispering gallery mode (WGM) resonator, have shown potential for high sensitivity and selectivity in humidity sensing applications. In contrary to polymer-based humidity sensors, glycerol droplets are insensitive to other volatile organic compounds.

Wavelength Sensing Based on Whispering Gallery Mode Mapping

In this paper [8], R. Berkis and co-authors present a study on laser wavelength sensing based on whispering gallery mode (WGM) mapping. It is based on WGM imaging of more than 10 PMMA microspheres attached to a tapered optical fiber. Paper demonstrates that this setup can be used for precise unknown laser wavelength determination.

Quality factor measurements for PMMA WGM microsphere resonators using fixed wavelength laser and temperature changes

A study on the quality factor (Q-factor) measurements of polymethyl methacrylate (PMMA) whispering gallery mode (WGM) microspheres, using a fixed-wavelength laser and temperature changes [9].

Scattering loss analysis in PMMA WGM micro resonator from surface irregularities

This paper investigates scattering loss in polymethyl methacrylate (PMMA) whispering gallery mode (WGM) micro resonators resulting from surface irregularities [10]. The research aims to provide a better understanding of the factors affecting the performance of PMMA WGM resonators, which is crucial for optimising their applications in various fields.

Mode family analysis for PMMA WGM micro resonators using spot intensity changes

The resonant modes within the cavity can be classified into different mode families, which determine the resonator's characteristics and performance [11]. Polymer PMMA microsphere is used as the resonator material in this study. This approach offers a simple, non-invasive, and cost-effective method for investigating the mode characteristics of WGM resonators.

Frequency comb generation in WGM microsphere-based generators for telecommunication applications

Silica microsphere-based optical frequency generators were fabricated, focusing on their potential applications in telecommunications [12]. Frequency combs are a set

of equally spaced frequency lines, which can be used for optical communications. In the context of telecommunications, frequency combs generated by WGM microsphere-based generators can be used for advanced modulation schemes, data encoding, and multiplexing, leading to improvements in data transmission rates, channel capacity, and spectral efficiency.

Frequency comb generation in whispering gallery mode silica microsphere resonators

The research demonstrates the potential advantages of using WGM silica microsphere resonators for frequency comb generation, such as their high efficiency, broad spectral coverage, and tenability [13]. These features make them promising candidates for optical communications.

Kerr optical frequency combs with multi-FSR mode spacing in silica microspheres

Research paper [14] explores the potential advantages of using WGM silica microsphere resonators for generating Kerr optical frequency combs with multi-FSR mode spacing, such as their high efficiency, broad spectral coverage, and tunability. These features make them promising candidates for various applications, including optical communications, precision metrology, and high-resolution spectroscopy.

Demonstration of a fiber optical communication system employing a silica microsphere-based OFC source

This paper [15] demonstrates a fiber optical communication system employing a silica microsphere-based optical frequency comb (OFC) source, highlighting the potential benefits of using silica microsphere resonators for frequency comb generation in optical communication systems. The research provides valuable insights into the properties and performance of these frequency combs, which could contribute to the advancement of optical communication technologies and systems.

Optical frequency combs generated in silica microspheres in the telecommunication C-, U-, and E-bands

The paper focuses on generating optical frequency combs in the C-, U-, and E-bands, which are significant for telecommunication applications [16]. The author discusses the fabrication techniques, experimental setup, and results obtained from the study. By understanding the factors influencing the performance of the frequency combs, such as the resonator's Q-factor, mode spacing, and pump power, it becomes possible to optimize the performance of the devices in various applications.

Silica Microsphere WGMR-Based Kerr-OFC Light Source and Its Application for High-Speed IM/DD Short-Reach Optical Interconnects

In this paper researchers investigate a silica microsphere whispering gallery mode resonator (WGMR)-based Kerr optical frequency comb (OFC) light source and its application for high-speed intensity modulation/direct detection (IM/DD) short-reach optical interconnects [17]. Optical interconnects are crucial for high-speed data transmission and communication systems, and employing Kerr-OFC light sources can lead to improved performance in these applications.

Nonlinear absorption and refraction of picosecond and femtosecond pulses in HgTe quantum dot films

In this paper, authors investigate the nonlinear absorption and refraction of picosecond and femtosecond pulses in mercury telluride (HgTe) quantum dot films [18]. Quantum dots (QDs) are semiconductor nanocrystals with unique optical and electronic properties, making them attractive for various applications in optoelectronics and photonics. The research contributes to the understanding and optimisation of HgTe QD films for ultrafast optical applications, paving the way for the development of novel photonic devices and systems.

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