Docket #: S23-142

Efficient optical spectroscopy with electro-optically mode-locked parametric oscillators

Researchers at Stanford have developed a new type of light source for spectroscopy applications, making it smaller and more energy efficient. Furthermore, this application allows a broad range of wavelengths without the interference from a pump laser.

Optical frequency combs have vastly advanced the fields of precision measurement and molecular spectroscopy. Despite the improvements, these instruments rely heavily on high-brightness coherent light sources, that can access a broad range of wavelengths. Thus, current methods lack concurrent high efficiency and wide bandwidth, limiting the applications.

Now, Safavi-Naeini's group have developed a method that overcomes these issues. Their electro-optically mode locked optical parametric oscillator produces an optical frequency comb that vastly improves both resolution and bandwidth. Furthermore, their discovery reduces the power consumption and footprint of the resulting light source, enabling a more deployable sensor.

Stage of Development

Prototype

Related Technologies:

23-219 - Ultra-broadband mid-infrared generation in dispersion-engineered thin-film lithium niobite

25-469 - Integrated widely-tunable optical parametric oscillator via electrically-tuned vernier effect

Applications

- Optical Spectroscopy
  - Gaseous solutions
  - Liquid solutions
- Biological samples
- Environmental monitoring
- Defense
- Medical imaging
- Agriculture and food production
- Process control

Advantages

- Decreased footprint with integration to deployable sensors
- Reduced power consumption
- Viable integration to complex photonic integrated circuits
- Improved range of wavelengths via dispersion engineering
- Increased resolution of dual-comb spectroscopy
- Less electrical capacity needed for photodetectors
- Reduced interference from pump laser

Publications

- Stokowski, H. S., Dean, D. J., Hwang, A. Y., Park, T., Celik, O. T., Jankowski, M., ... & Safavi-Naeini, A. H. (2023). Integrated frequency-modulated optical parametric oscillator. arXiv preprint arXiv:2307.04200.
- Hwang, A. Y., Stokowski, H. S., Park, T., Jankowski, M., McKenna, T. P., Langrock, C., ... & Safavi-Naeini, A. H. (2023). Mid-infrared spectroscopy with a broadly tunable thin-film lithium niobate optical parametric oscillator. arXiv preprint arXiv:2307.04199.

Patents

- Published Application: WO2024216166
- Published Application: 20260277072

Innovators

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