.: Single-cavity Laser Emits High-Power, Dual-Comb Femtosecond Pulses

Researchers at ETH Zurich have developed a method that uses a single laser cavity to create two high-powered optical frequency combs, emitting high-power femtosecond pulses. The advance supports potential future developments that move toward designing more compact dual combs that offer flexibility in power, wavelength, bandwidth, and pulse repetition rates.

Those combs would be able to support development of dual-comb light sources for **spectroscopy** and precision distance measurements.

The researchers used a single laser cavity multiplexed with birefringent calcite crystals to allow for lasing in the two polarization states, and combined this birefringent crystal polarization multiplexing technique with a diode-pumped solid-state laser crystal. The Yb:CaF_2 gain crystal enabled high-powered femtosecond (fs) pulse generation, due to its strong thermal properties and broad emission spectrum.

With that configuration, the researchers achieved pulses with a 175-fs duration and 440 mW of power in two 1050-nm beams with a repetition rate difference of 1 kHz. They demonstrated the stability of the repetition rate difference by using the laser to perform low-noise measurements on semiconductor materials using asynchronous optical sampling. This involved using an ultrafast pulse to trigger a reaction, and a second pulse to measure the induced change.

“Our approach allows us to generate a pair of frequency combs with a small and passively stable offset in their repetition rate,” said Benjamin Willenberg of ETH Zurich. “This resolves the long-standing problem of the high complexity of dual-comb systems without compromising on laser performance. Potential sensing applications include time-domain spectroscopy for nondestructive testing, trace gas detection for industrial and environmental monitoring, and laser ranging for **machine vision** applications.”

The train of optical pulses available from dual-comb lasers are particularly useful for extremely sensitive and fast spectroscopic measurements, and precisely measuring distances via laser ranging. However, the need for two stabilized combs plus complex synchronization electronics has restricted these measurements to the laboratory.

Next steps for the technology include developing prototype systems in a robust and portable package, demonstrating scientific and industrial applications, scaling to higher powers and higher repetition rates for faster measurements, and setting up channels to offer the laser commercially.

The research was published in *Optics Express* (www.doi.org/10.1364/OE.403072).

Photonics Spectra
Jan 2021

GLOSSARY

machine vision

Interpretation of an image of an object or scene through the use of optical noncontact sensing mechanisms for the purpose of obtaining information and/or controlling machines or processes.