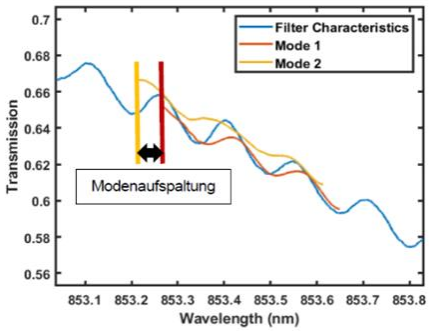
Optical Strain Gauge

Obtaining strain data by measuring polarization modes

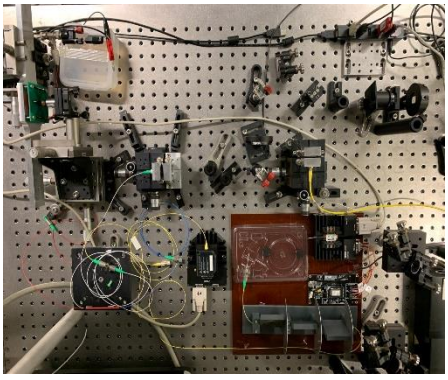
Invention

To what kinds of static and dynamic loads are parts exposed? What is their vibration in the high-frequency range? This data is usually obtained through electrical strain gauges.

However, in critical work environments, such as those with a high risk of explosion or with high, pulsing magnetic fields, optical strain gauges are superior. An optical strain gauge from Ruhr University in Bochum has now improved this approach by creating the sensor element from a special semiconductor-based laser diode called a VCSEL (vertical-cavity surface-emitting laser), in which mechanical stresses induce mode splitting: The relative wavelength shift of two differently polarized modes produces the strain-based measurement signal. This makes it possible to create a high-resolution, fully optical, compact and low-cost sensor that can be powered without any electrical wiring. It is connected to the compact pump laser source and analysis electronics unit by a single fiber-optic cable. Using a novel spin VCSEL also greatly improves measuring accuracy.



Mode intensity after transmission through the filter.



Measurement setup in the Ruhr University Bochum lab.

Commercial Opportunities

Strain gauges can be found in a number of applications. Aside from mechanical stress, they can measure a variety of values, such as length, pressure, temperature, sound, and acceleration, when other material parameters are established. This makes them an interesting option in industrial metrology as well as consumer electronics. This novel sensor can make new commercial products possible in a broad range of applications, all of which would exhibit high measuring accuracy and be inexpensive to manufacture.

Current Status

An experimental proof-of-concept has been built that demonstrates basic functionality. An application has been submitted to the German Patent and Trademark Office, with subsequent applications in other countries possible in the priority year or as part of a later PCT application. We are offering interested companies the opportunity to license and continue to develop this technology with the inventors at Ruhr University in Bochum.

Relevant Publications

M. Lindemann, N. Jung, P. Stadler et al., Bias current and temperature dependence of polarization dynamics in spin-lasers with electrically tunable birefringence, AIP Advances 10, 035211 (2020) https://doi.org/10.1063/1.5139199

An invention of Ruhr University Bochum.

Competitive Advantages

- Low-cost sensor principle
- Small, compact design
- Resistant to EM interference
- Designed to measure length, pressure, temperature, sound, acceleration

Technology Readiness Level

1 2 3 4 5 6 7 8 9

Experimental proof of concept

Industries

- Electrical engineering
- Sensor technology
- Metrology

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