Broadband Vibration Sensors Using Fiber Bragg Gratings

Kenji Sato
National Institute of Technology, Numazu College, Japan

Introduction

Object

- Broadband (~100 kHz) and reproducible vibration sensor

Background

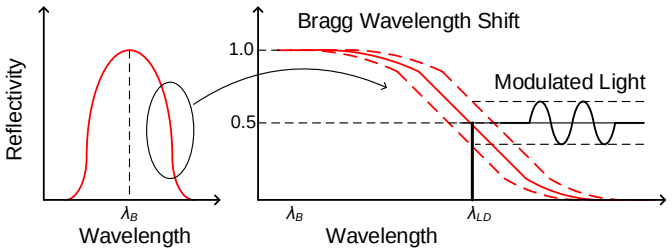
- Fatigue damages and disasters to infrastructure
- Structure health monitoring
- Optical sensor: high sensitive, but unstable due to temperature etc.

Principle and Design

Operation principle

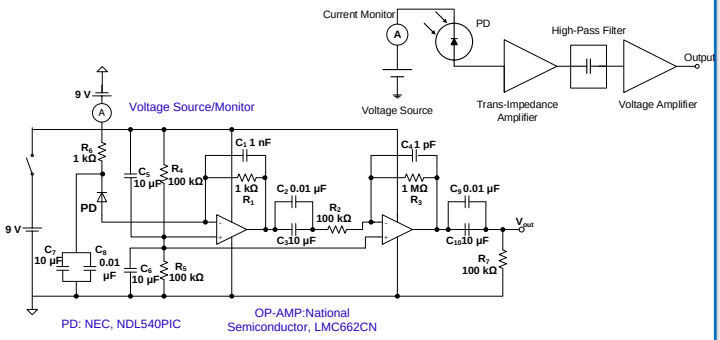
- Strain-induced Bragg-wavelength shift
- Reflection slope of FBG (fiber Bragg grating) acts as strain-intensity converter

→ *High-sensitive vibration sensor*



1. Light-voltage conversion circuit

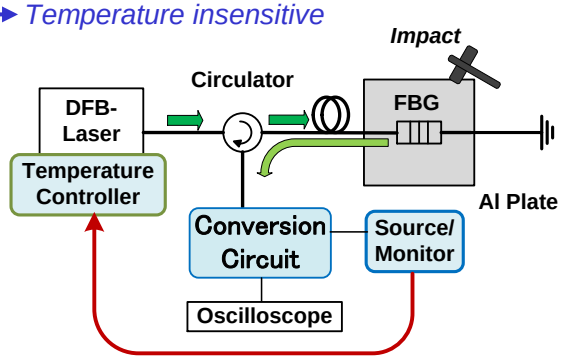
- Bandwidth: 1 Hz ~ 100 kHz
- PD current monitor for stabilization



2. Configuration of vibration sensor

- Laser-wavelength control maintaining PD current

→ *Temperature insensitive*



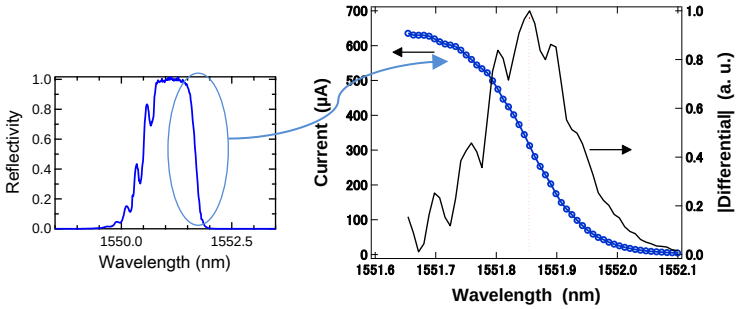
Conclusion

- Broadband (0.3 Hz to 50 kHz) vibration sensor using FBG
- Temperature insensitivity by control of laser wavelength maintaining PD current at inspection point

Experimental Results

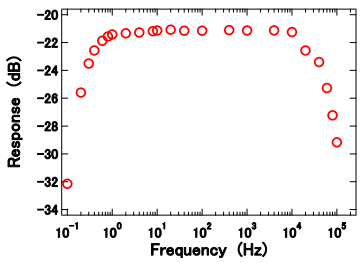
1. Reflection spectrum of FBG

- Linearity and bandwidth of reflection slope
- Inspection point at half maximum



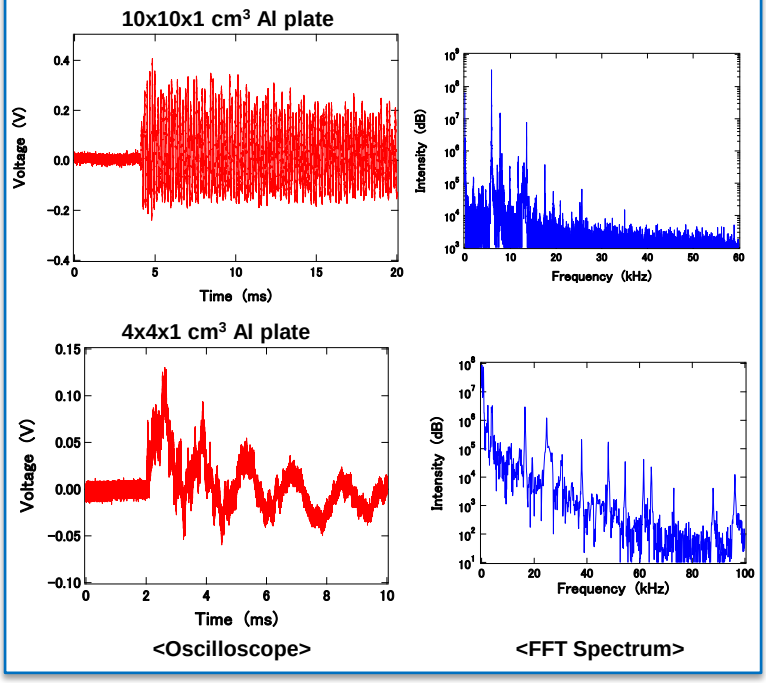
2. Bandwidth of the conversion circuit

- 3 dB bandwidth:
  0.3 Hz – 50 kHz
  OP-amp limited



3. Responses to impact tests

- Components up to 90 kHz are observed
- A 0.1-V output corresponds to 23-μ strain change
  (2.5-K temperature change)



<Oscilloscope> <FFT Spectrum>