실리콘 V-홈 지지대를 이용한 광세기변화형 단일모드 광섬유 가속도센서

An Intensity-Based Single-Mode Fiber-Optic Accelerometer Using the Silicon V-Grooves

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Recently, many researches, which based on capacitive type, piezoresistive type, piezoelectric type, have been progressed. These acceleration sensor using silicon have a lot of advantages, good mechanical property[1], small size, integration, low cost, because photolithography process is possible. However it has also disadvantage, low temperature range, low precision, while fiber-optic sensors have much attention because of their distinct advantage, such as light weight, passive nature, low power, resistance to electromagnetic interference, high sensitivity, wide bandwidth, and environmental ruggedness[2,3]. In this study, new acceleration sensor, using single-mode optical-fiber and V-grooves by silicon anisotropic etching, was demonstrated.

Fabricated sensor consists of two optical fibers, one is input fiber(cantilever beam) and the other is detection. The core diameter of single-mode optical-fiber is 8㎛ and the airgap between two fibers is 10㎛. When the sensor is under an acceleration, the cantilever beam deflects because of inertia. The top and cross-sectional views of the sensor is displayed in Fig. 1. The light source was used He-Ne laser(λ=633㎚) and condensed to input fiber by lens. When the light is transmitted from one fiber to another, an intensity variation of output light occur under an acceleration. The variation of output light is measured by electronic instrumentations which include optical powermeter, function generator, vibrating table, preamplifier, and oscilloscope.

One of the main problems in cantilever accelerometer using optical fiber is the suspicion that there are other axis cantilever movements to the initially vibrated direction by its cylindrical shape. But we could get rid of this suspicion due to the experiments that confirmed while the vibration became stronger, other axis cantilever movements to the initially vibrated direction weaker.

Fig. 3 shows the output characteristics for the sensors with cantilever lengths of 17㎜, 18㎜, and 19㎜ in the acceleration range 0.1~0.9g. The sensitivity, as expected, increased with the increasing cantilever length. The sensitivities of each cantilever were differently exhibited at before and behind acceleration value of 0.3g. This is the result of a misalignment of core center between the two optical fibers. The characteristics were less linear than expected. It is considered that some scatter of results is caused by the test-sensor construction. The available linear range from each characteristics in Fig. 3 was less than 0.3g. Fig. 4 shows the frequency characteristics of the sensor for cantilever lengths of 17㎜, 18㎜, and 19㎜. For measuring the resonance frequency, the sensor was vibrated with a acceleration magnitude of 0.2g and the exciting frequency range was from 100Hz to 700Hz. The resonance frequencies for cantilever lengths of 17㎜, 18㎜, and 19㎜ were 300Hz, 250Hz, and 200Hz, respectively. The resonance frequency, as expected, increased with the decreasing cantilever length.

In conclusions, a new fiber-optic accelerometer has been developed using the single-mode optical fiber and the V-grooves by silicon anisotropic etching. It is of simple construction, cheap, robust and does not require any complex instrumentation. The characteristic of the sensor is dependent on the cantilever length, the gap width and frequency. Further research is underway to obtain more characteristics of the cantilever fiber-optic accelerometer.

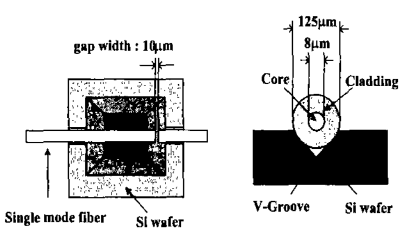

Fig. 1. Top and cross-sectional views of the sensor.

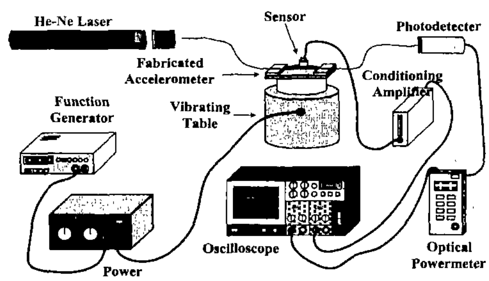

Fig. 2. Set-up for measurement of the sensor.

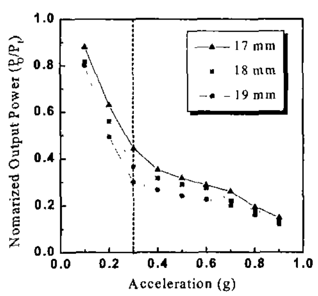

Fig. 3. Output characteristic as a function of acceleration. (Operation frequency:20Hz)

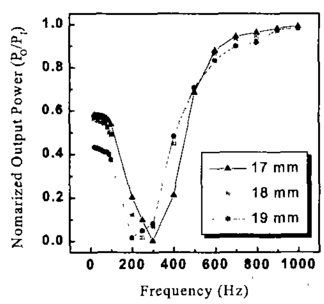

Fig. 4. Frequency response of the sensor. (Operation acceleration:0.2g)

[1] J.C. Greenwood, "Silicon in a mechanical sensors", J. phys. E, Sci. Instrum., vol.21, pp.1114-1128 (1988).

[2] K.E. Petersen, "Silicon as a Mechanical Material", proc. IEEE, vol.70, no.5, pp.420-457 (1982).

[3] Jerzy Kalenik, Ryszard Pajak, "A cantilever optical-fiber accelerometer", Sensors and Actuators, vol.A68, pp.350-355 (1998).