2P2-11

Experiment and Simulation of Polished Surface Reflections using Ultraviolet Laser Diodes for Laser Speckle Interferometers

レーザスペックルにおける紫外光源を用いた鏡面反射の実験とシミュレーション

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1. Introduction

The laser speckle method is used for measuring piezoelectric devices, and various techniques have been developed. A finishing method is used to polish a frequency device of high-frequency radio equipment that involves the satin process, resulting in a decrease in spurious vibration.

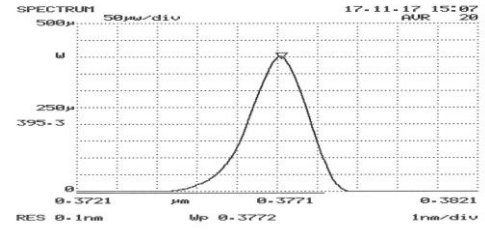
We conducted an experiment involving ultraviolet (λ = 377 nm), purple (465 nm), and red (656 nm) laser diodes (LDs). During USE2017, polished surfaces of aluminum (Al) and gold (Au) exhibited a reflection angle of 15 degrees from the horizontal surface.

However, other angles were not obtained and immediate measures were necessary. A polished surface originally goes, and the laser speckle method does not work if the surface is completely flat but is effective if there is even slight a distortion on the polished surface. However, the electrode surface curves peculiar to the resonator.

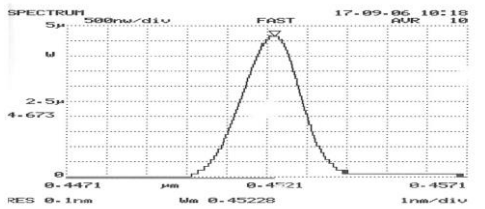
Therefore, our first goal of this study was to obtain a reflection angle of 30 degrees. We clarified through simulation that there are distortions on polished surfaces; therefore, we considered re-designing an electrode surface.

2. Experiment procedure

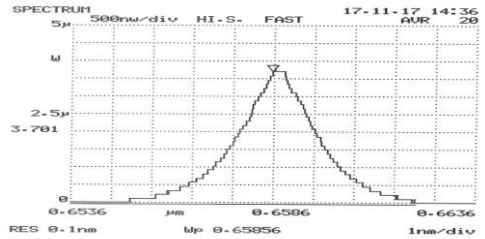
As in USE2017, we chose Al and Au as polished surfaces and 377, 452, and 656 nm as laser wavelengths. Figure 1 shows the results from measuring each wavelength of the LDs. We used an optical spectrum analyzer for measurement. As shown in Figure 1, a laser wavelength was found than this exactly. Figure 2 shows the experimental system, which was basically the same as that used in USE2017, but we added a ND and a wavelength plates.



(a)



(b)



(c)

Fig. 1　Measurement results of optical spectrum analyzer, (a) 377 nm, (b) 456 nm and (c) 656 nm.

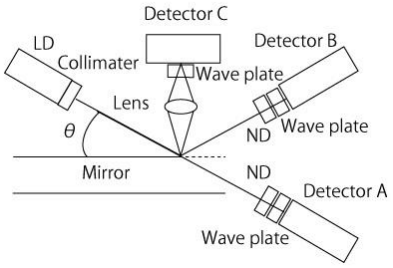


Fig. 2　Experimental setup.

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3. Experimental results

Figure 3 compares our results with those from USE2017. The results marked with "≒ 0.9" are those obtained from USE2017 for simulation of an Al surface for each wavelength, and the value that, moreover, demanded it by an experiment is used. Measurement was carried out ten times, and a mean value for each wavelength was obtained. For the Au surface, there were 1-2% error at angles of 15 and 30 degrees during the simulation compared to those from the measurement, as shown in Table 1.

The way where the value in the error range is obtained is great without depending on a , that is, laser wave length.

4. Simulation

If a polished surface is flat, the laser speckle method does not work. A flat reflection means nothing changes saying that piezoelectric resonator moved. The "coarseness" of the polished surface is key to solving this problem.

An error called λ/10 produces this for polished surface from a specification document. It is simulated without receiving it here, and the influence that an error of λ/10 gives for the laser speckle method is considered. Figure 4 shows the simulated laser angles. As a result of having put λ/10 between it, we are not sure if the results from the laser speckle method can be reproduced through simulation in the component for the moment. This is for future work.

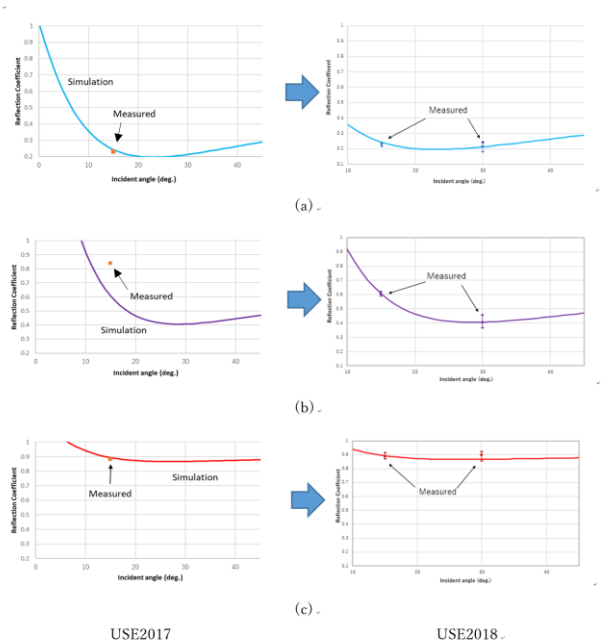

Fig. 3 Measurement results of USE2017 to USE2018, (a) 377 nm, (b) 456 nm and (c) 656 nm.

Table I Experiments vs. simulations.
(Error percentage from simulation of measurement average)

Laser Wavelength	Experiment 15 deg. (%)	Simulation 15 deg.
377 nm	0.23 ± 0.03 (1)	0.24
456 nm	0.62 ± 0.05 (0)	0.62
656 nm	0.89 ± 0.05 (1)	0.88
Laser Wavelength	Experiment 30 deg. (%)	Simulation 30 deg.
377 nm	0.21 ± 0.01 (1)	0.22
456 nm	0.40 ± 0.02 (1)	0.41
656 nm	0.89 ± 0.03 (2)	0.87

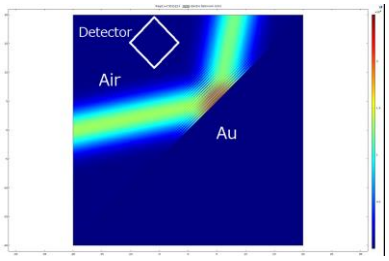

Fig. 4 Schematic of simulation.

5. Conclusions

The polished surface reflection using the ultraviolet ray laser was demanded based on the Laser Speckle method in this report exactly. As a result, 1-2% and well agreed measurement were able to be obtained. And, by the simulation, a laser light source was set optionally as a pre-stage, and it was decided to use air and Au. An error is assumed around λ/10, and examination wants to be pushed forward in the future. In addition, we will going to examine the simulation that added the shape of the electrode sequentially.

Acknowledgment

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References

1. Yunhao Ma, et. Al, USE2017 1P2-2 (2017)
2. Yunhao Ma, et. Al, JSAP Spring Meeting, 19p-P2-1, (2018)