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Polished Surface Measurements at Ultraviolet Wavelengths for Laser-speckle Methods

Laser Speckle のための UV レーザを用いた鏡面測定

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1. Introduction

The laser speckle method is a method for making piezoelectric measurements for various applications such as mirror finishing, polished surfase and high frequency cable broadcasting[1-8]. In this research, the reflectance ratio for a mirror finish was measured at UV wavelengths of 377 nm and 456 nm for the laser speckle methods[9].

Specifically, using an incident laser, the scattering reflectance ratio for the mirror finish was determined by a detector installed in the vertical direction. A simulation and an experiment were performed but yielded incongruent results, with better results obtained by simulation.

2. Test outline

Al (aluminum) and Au (gold) were chosen for the polished surface because quartz crystal electrodes are usually made of gold, and aluminum can be used as a reference for comparison. For the 377 nm UV wavelength, 456 nm and 656 nm blue lasers were chosen for the laser diodes (LDs). Results were measured for all wavelengths by a light spectrum analyzer.

Figure 1 (a) and (b) respectively show a simple diagram and a more detailed diagram of the experimental setup. In Fig. 1 (a), the light from the LD is completely refracted from the polished surface and enters detector B. In Fig. 1 (b), the light from the LD is partially scattered and is detected by detector C. Here, θ represents the angle-of-incidence. In addition, detector A is used to detect the reference light and scattered light in detectors B and C.

Figure 2 (a) and (b) are the simulation results, where (a) = Al and (b) = Au. For (a), a constant reflected wave was obtained regardless of the wavelength.

Similarly, compared with (a), (b) clearly shows many reflected waves regardless of the wavelength.

The lasers were fixed at the next step, resulting in diagonal incidences. Assuming 15 degree uniformity by the angle when changing each laser, detector C measured a scattered reflection.

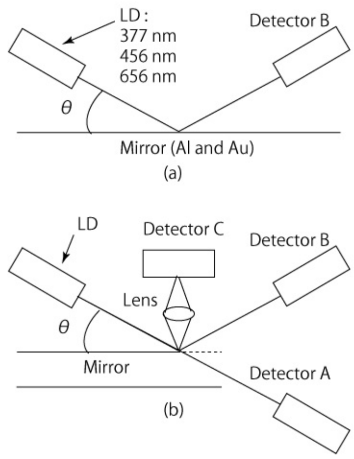

Fig. 1 Experimental setup. (a) simple diagram, (b) detailed diagram.

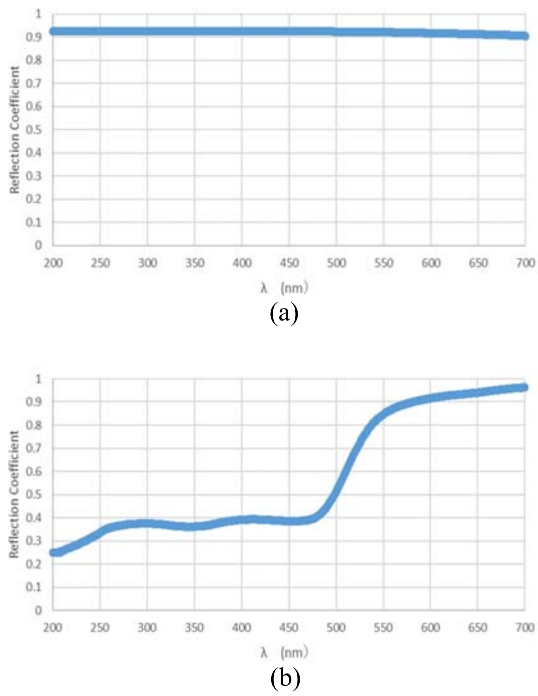

Fig. 2 Simulation results in reflection coefficient vs. wavelength of LDs. (a) aluminum, (b) gold.

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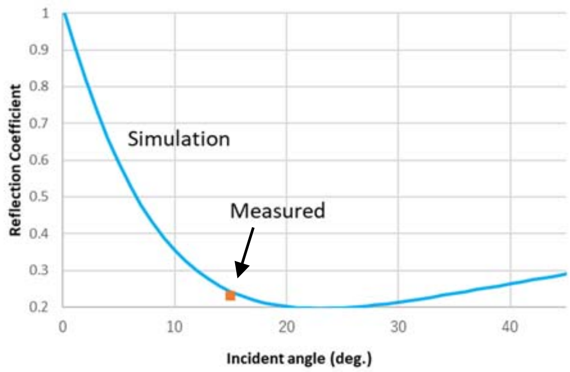
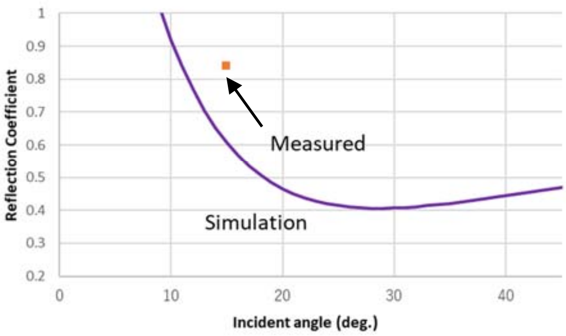
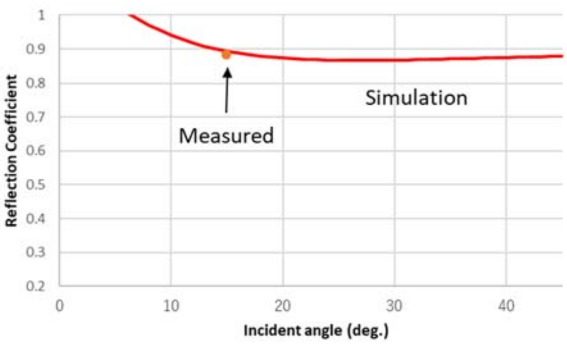


(a) 377 nm



(b) 456 nm



(c) 656 nm

Fig. 3 Experimental data and simulations.
(a) 377 nm, (b) 456 nm, and (c) 656 nm.

In addition, the light was collimated, and the laser was approximately 0.7 mm in diameter and the lock-in amplifire had been used to detector C.

Moreover, a direct light and a borrowed light were divided between detector A and B by moving the polished surface to the right and left. Direct light voltage by detector B was assumed to be V_0 using an ND filter, and the reflection voltage of detector C was equally assumed to be V_1. Light detectability factor S can be represented by the following formula.

$$S = | V_1/V_0 | \qquad (1)$$

3. Experimental results

Figure 3 (a), (b), and (c) represent the simulation results of the reflectance ratio for the wavelength where the angle is 15 degrees and the LD wavelengths are 377 nm, 456 nm, and 656 nm each. The experimental value by equation (1) is additionally shown. As a result, at 377 nm and 656 nm, the experimental results agreed with those of the simulation by less than 1 %, whereas they did not agree at all at 456 nm. The cause of this is unknown at the moment.

4. Conclusions

Experiments for changing an LD wavelength to a UV wavelength were carried out. As a result of choosing 377 nm, 456 nm, and 656 nm as wavelengths, and having measured the reflectance ratio for each, the experimental results agreed with those of the simulation by less than 1 % at 377 nm and 656 nm.

In the future, the simulation and experiment will be repeated because the results did not agree at all at 456 nm.

Acknowledgment

This work was supported by Grant-in-Aid for Scientific Research 17k06466 in the Ministry of Education, Culture, Sports, Science and Technology.

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