Precise profilometry for scattered media and tomography for multiple-layers samples using the Discrete frequency scanning laser

Tuan Cong Truong [1], Tuan Quoc Banh [1,2], and Tatsutoshi Shioda[1]
Graduate School of Science and Engineering, Saitama University[1)], Sevensix Inc.[2)]
E-mail: tshioda@mail.saitama-u.ac.jp

We propose the novel discrete frequency scanning laser of 200 GHz scanning step for industrial profilometry and tomography. The laser ring cavity of the proposed light source consists of a lasing medium, a frequency tuning part, and the Fabry-Perot etalon as a frequency comb generator. The proposed light source is used in the precise profilometry and tomography for the scattered media and multiple-layers samples, respectively.

1. Introductions

The optical frequency comb (OFC) interferometry whose spectral frequency range (FSR) of hundreds GHz has been reported [1,2]. However, it was difficult to employ the ordinary frequency combs for highly scattered or absorbed samples because of the high-losses optical resonator. In order to overcome this problem, we propose the discrete frequency scanning laser in which each output frequency plays as a pseudo comb with high intensity peak [3,4].

In this paper, a measurement of the tomograms and surface profile of highly scattered sample and a multiple-layers glass sample will be demonstrated, respectively.

2. System setup

Fig. 1 shows the setup of proposed system. The ring cavity includes a semiconductor optical amplifier (BOA types), the Fabry-Perot etalon, a polygon mirror and a diffraction grating. The resonant frequencies of the etalon are consequently selected by the polygon mirror and the grating. Each selected frequency is oscillated and lased.

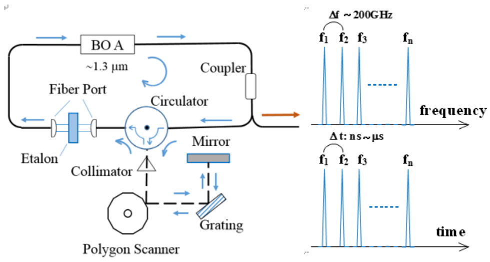

Fig. 1: Schematic for generation of discrete frequency scanning laser.

3. Experimental results

The schematic of single-shot interferometry is shown in Fig. 2. The lenses with 4-*f* configuration are used to optimize the quality of the CCD camera interference images. In the first experiment, we measure a multiple-layers glass sample as a demonstration of the tomography. As shown in Fig. 3, the optical thickness of the glass layers are 287 μm and 292μm, respectively. This results are good agreement with physical thickness 200μm±5μm of glass sample (n~ 1.5). Fig. 4 shows the single-shot 2-D image and 3-D reconstruction image of number “5” on the 50 JPY coin as a surface profile

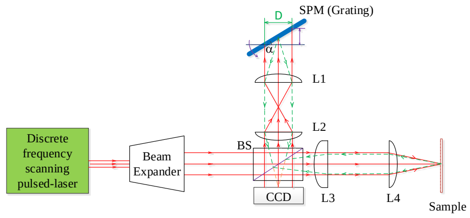

Fig. 2: Schematic of single-shot system

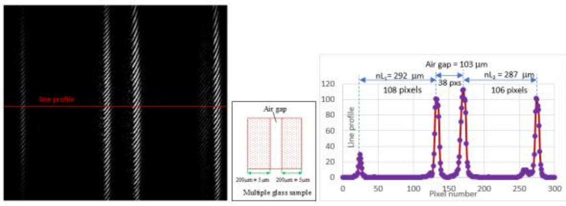

Fig. 3 Tomography image of multiple-layers glass sample

measurement of a scattering media. The clearly obtained 3-D image of the sample indicate the effectiveness of the proposed system for the scattered sample.

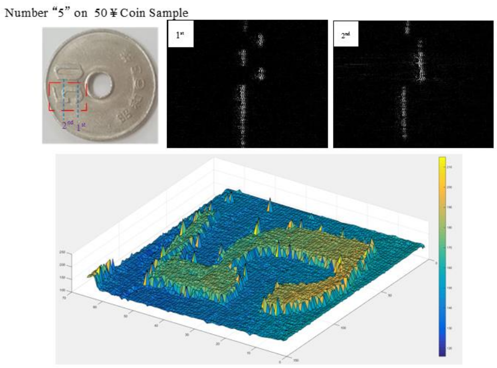

Fig. 4: Single-shot 2D image and 3D reconstruction image of number ”5” on the 50 JPY Coin

4. Conclusions

The demonstration for profilometry and tomography of multiple glass sample and scattered media by using the discrete frequency scanning laser is developed. This experiment results confirmed the proposed light source has high potential to measure highly scatter sample as well as tomogram image of multiple-layers sample. This study was partially supported by JSPS KAKENHI Grant Numbers JP16H03879, JP15K13372.

References

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