2015 中技社外籍研究生科技研究獎學金

CTCI Science and Technology Research Scholarship for International Graduate Students in Taiwan

# Shearing interference microscope with phase-shifting and phase-scanning measurement modes

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## 1. Research Focus

We have introduced a new shearing interference microscope for surface step-height measurements by using two measurement modes: phase-shifting and phase-scanning mode. In this system, two Savart prisms, one separates the incident beam into two parallel beams with a small lateral shearing; the other one recombines both two beams are utilized. The recombined beam passes through an analyzer that produces an interference pattern, which contains the phase information of contour surface. To verify feasibility and application of this system, two measurements, one for determining the 3μm of step-height standard using the phase-scanning mode and the other for measuring the 86nm of step-height standard using the phase-shifting mode are presented.

## 2. Research Results

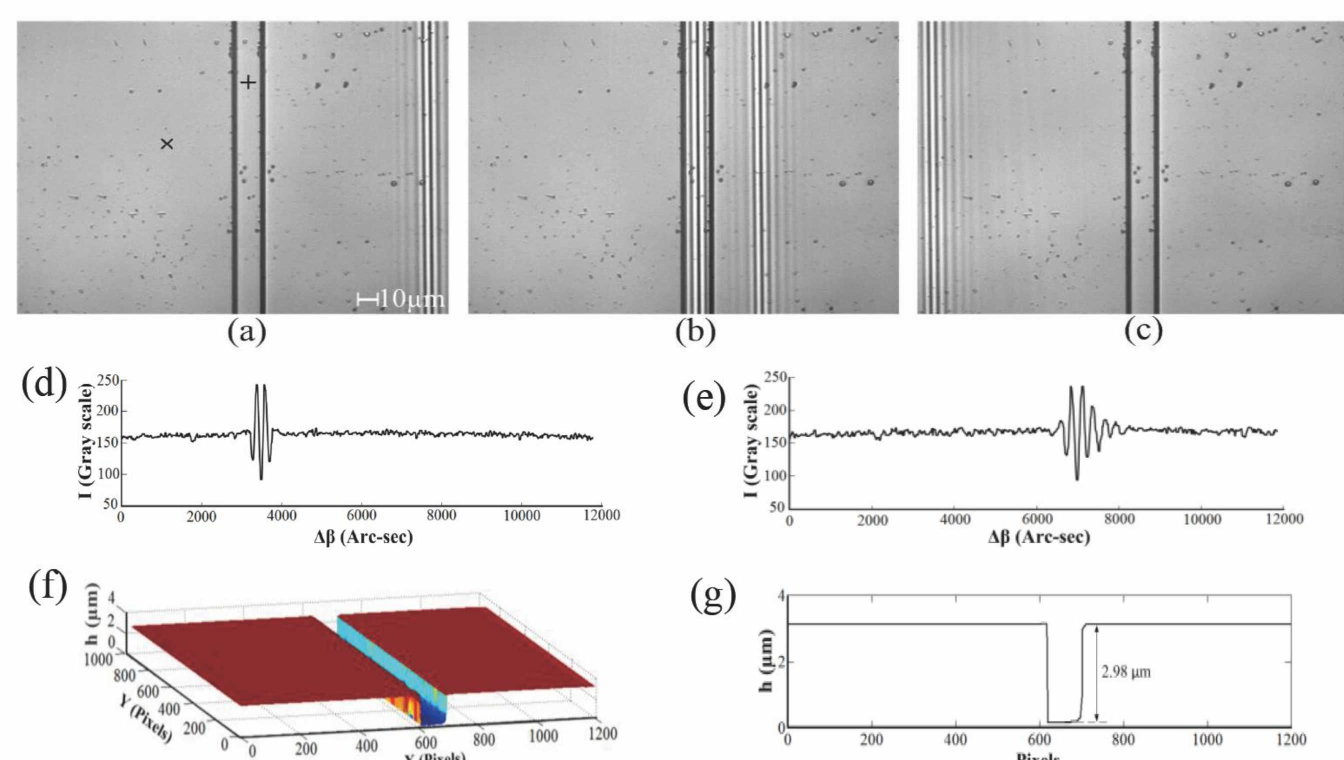

Fig. 1 (a-c) Three interference patterns; (d-e) the correlograms of the points + and ×, (f) the measured contour of the step-height standard; (g) the cross-section at y = 500-pixel

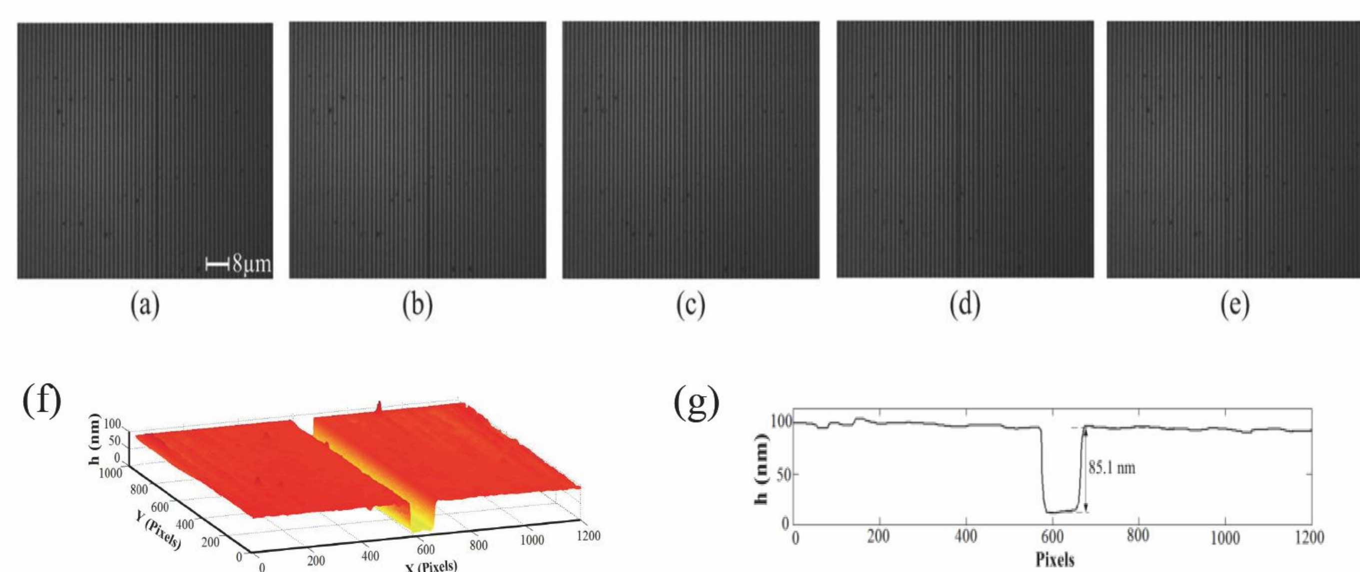

Fig. 2 (a-e) The five interference patterns; (f) measured contour of the step-height standard; (g) the cross-section at y = 500-pixel

### Phase-scanning measurement mode

- The result of 3μm of step-height standard from VLSI was measured by using phase-scanning mode as shown in Fig. 1.
- The three interference patterns corresponding to scanning angles of 695, 4865, and 9730 arc-sec, respectively as shown in Figs. 1a-c
- In Figs. 1d-e, the two correlograms ( i.e., plots of intensity vs. scanning angle) of the points + and ×, respectively, indicated in Fig. 1a, they demonstrate that every effective point has a distinguishable minimum value in intensity, accordingly the contour height of every point can be retrieved without ambiguity by using the phase-scanning measurement mode.
- The retrieved contour of the step-height standard is displayed in Fig. 1f.
- The experimental result of 3μm step-height standard, which can be only measured by using phase-scanning mode has a height of 2.98 μm as shown in Fig. 1g

### Phase-shifting measurement mode

- The experimental results of the phase-shifting measurement mode is proposed to measure the 86nm step-height standard as shown in Fig. 2.
- The five interference patterns corresponding to phase-shifts of 0, $\pi/2$, $\pi$, $3\pi/2$, and $2\pi$ are revealed in Figs. 2a-e, respectively.
- The contour obtained from using these five patterns is shown in Fig. 2f; and the cross-section of $y$ = 500-pixel indicated that the height from the measured contour is 85.1 nm as shown in Fig. 2g.
- This method can only measure a step-height that has height less than a water wavelength.

## 3. Research Experience

Studying abroad in new environment brings me so many difficulties and challenges. During this time, I have worked hard to broaden my knowledge and my understandings in the area of optical metrology, and learn how to control complicated equipment and facilities. Fortunately, I has received the great supports from my advisor and lab-mates in research work and life in Tainan. I have never thought that I could achieve such a fantastic result without their helps. I also would like to express my sincere thanks to my parents and my friends for their love and encouragement. Last but not least, I would like to thank you the CTCI Foundation for offering us an amazing honor to share our recent studies.