

SURFACE MEASUREMENT BY ENCODING AND DECODING OF POLARIZATION DISTRIBUTION

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We have developed a simple and sensitive detection system for nano-steps and slight surface undulation of smooth wafer surface. In a reflection microscope, a q-plate which is a half-wave-plate with azimuthal rotation of the principal axes was implemented at the pupil plane behind the objective. Figure 1 shows the schematics of the optical system. The incident linearly polarized beam is encoded an axial symmetric polarization distribution, and the polarization of reflected beam is reversed to the same polarization of incident beam by the inverse pass of the same q-plate. When the light reflected by scattering at the edge of sharp step or surface tilt on the sample, reflected beam behind q-plate contains different polarization of incident beam. So that we can detect the nano-level steps and waviness of smooth surface as the change of polarization.

Figure 2 shows the reflection images of a microscale which has 10 μm pitch trenches on the metal thin film mirror deposited on silica substrate. Hence, the scale lines are observed as a black line and metal surface as white area on bright-field microscope because the light is reflected by silica in Fig. 1 (a) and (b). When q-plate was implemented in this system, reflection from metal surface was attenuated by polarizer, and the diffusion from the edge of the scale line is observed as white line at the both side of the scale line in Fig. 2(d). Under the higher sensitivity mode, defect and roughness of the metal surface is observed as a texture shown in Fig. 2 (e). In our system, we estimated the sensitivity of step size was less than 10 nm, and of tilt angle was 0.005 deg.

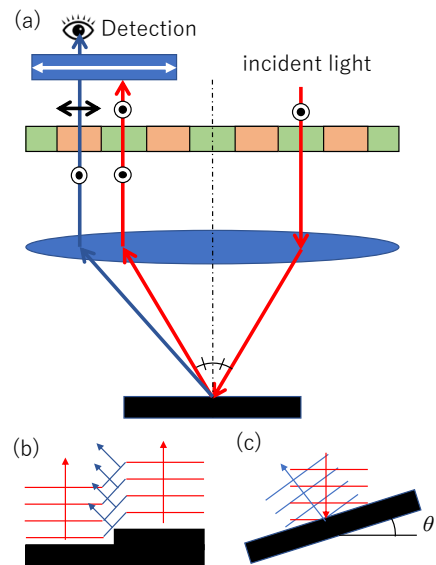


Fig. 1. Detection of beam shift by step (b) and tilt of surface (c).

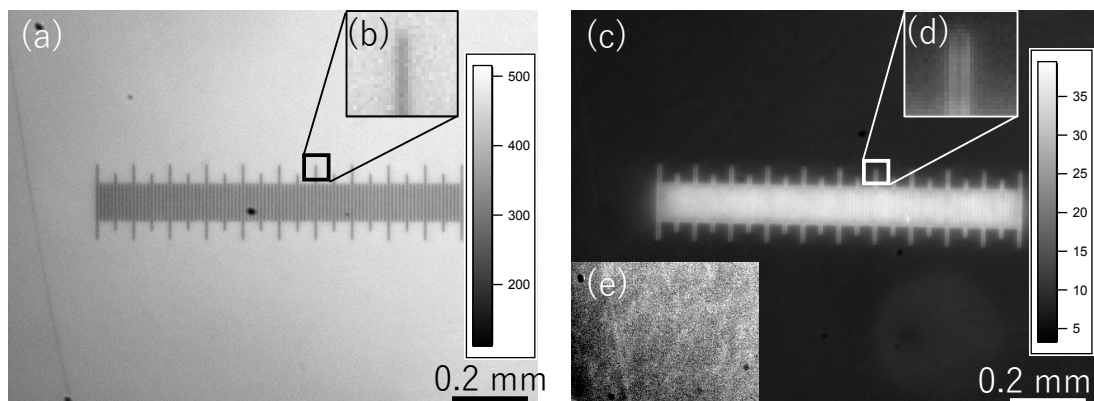


Fig. 2. Reflection images of a metallic microscale: bright field images (a) and (b), darkfield images with q-plate (c), (d), and (e). (e) is an intensified image of metal plane.