Tunable phase detection sensitivity of grating-coupled surface plasmon resonance (SPR) Sensor in a Phase-Shift Interferometry (PSI) Image System

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The surface plasmon resonance (SPR) phenomenon has commonly been applied in bio-chemical sensors [1]. There are two major coupling mechanisms, a prism or a grating coupler. The grating-coupled sensor chip can be fabricated by low cost nano-imprinting technique [2]. For the detection method, intensity or phase of incident light can be used. In our previous study, we report a phase detection method for the SPR sensor can be tuned by simply rotating the analyzer in a heterodyne interferometer (HI) system [3]. In this paper, we apply this method in an image type measurement to a grating- coupled SPR (GCSPR) sensor by using liquid crystal (LC) phase-shift interferometry (PSI) [4]. A prism-coupled SPR using PSI has been reported [5]. Comparing with our previous HI system, the major advantage of the image type PSI system can perform multi-channel measurement.

The GCSPR sensor structure is shown in Fig. 1. A *p*-polarized light beam is incident on the structure at an angle of θ. The sensor was fabricated by nano-imprinting technique, the detail can be found in our previous paper [2]. The device parameters: pitch Λ=840 nm; depth h=70 nm; and the metal thickness d = 70 nm.

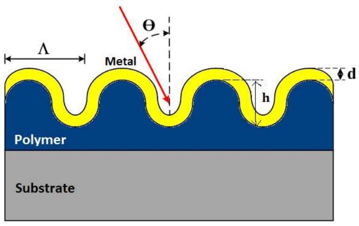

Fig. 1. schematic of the GCSPR sensor

The experimental system is shown in Fig. 2. The expanded laser beam is polarized at 45°, and then focused into a line on the GCSPR sensor by a cylindrical lens. The phase retardation between *p*- and *s*-polarization components is modulated by the LC phase plate. A webcam is used to capture the final image. In order to calculate the phase retardation caused by GCSPR sensor, the LC controller need to set the phase plate to be five phase retardation values: 0, $\pi/2$, π, $-\pi$, $3\pi/2$ [4]. An example image captured by the webcam and intensity profile alone the horizontal line pixels are shown in Fig. 3. The experimental tunable phase curves of different analyzer rotation angles β are shown in Fig. 4. For three positive and three negative phase slopes near resonance points, β=147° and β=142° has the maximum slopes, respectively. The system has the best sensitivity when the analyzer angles are set to these values. The results show that the system detection sensitivity can be tuned by rotating the analyzer.

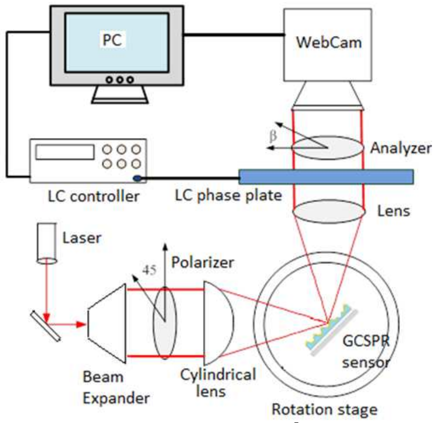

Fig. 2. Experimental system.

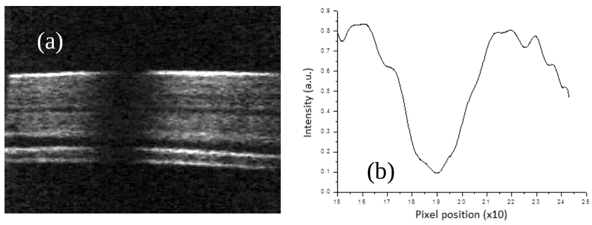

Fig. 3. (a) Example captured image. (b) Intensity profile alone the horizontal line pixel.

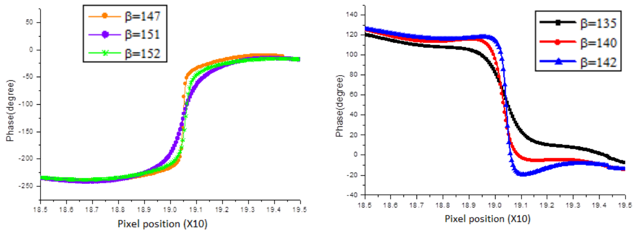

Fig. 4. Tunable phase curves of different analyzer rotation angles β. (a) positive and (b) negative slopes

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