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Precision Profile Measurement System for Microholes Using Vibrating Optical Fiber

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In this study, we have proposed and implemented a profile measurement system for microholes using an optical fiber probe equipped with a vibrating mechanism driven by a piezoelectric element. The optical fiber probe consists of a stylus shaft of 3 μm diameter and a glass ball of 5 μm diameter attached to the tip. The principle involves the monitoring of the stylus shaft displacement by detecting a change in the amount of light received by two dual-element photodiodes. These diodes are set up facing laser beams that are irradiated onto the shaft portion from the X and Y directions. In this study, a tube-type piezoelectric element was set at the base of the stylus allowing it to vibrate in the X and Y directions. Firstly, we examined the displacement detection characteristics and frequency response characteristics of the probe. Secondly, the performance of the vibrating mechanism was examined. Finally, the measurement performance of the fiber probe was experimentally examined by measuring a hole of 150 μm diameter. The stylus could be operated in a circular path of 9.69 μm diameter. The changes in amplitude and phase of vibration of the stylus allowed for contact detection with the hole wall. Our study has potential applications for measurements of microholes in the diameter range of 10–150 μm.

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