

## Development of a Piezo-driven Mechanical Stage Integrated Microdisplacement Sensor for Calibration of Displacements

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We fabricated a mechanical stage driven by a piezoelectric actuator and built in a microdisplacement sensor, which is used to decrease the effect of hysteresis and creep in the piezoelectric actuator. The displacement sensor consists of a vertical-cavity surface-emitting laser (VCSEL), eight two-dimensional monolithically integrated photodiodes (PDs), a frame, and a cover glass. The size of the sensor chip is 3.0 mm by 3.0 mm with a thickness of 0.7 mm. The maximum variation in the position of the mechanical stage caused by hysteresis is 7.5  $\mu\text{m}$  without control when the movement range of the mechanical stage is 84.4  $\mu\text{m}$ . By controlling the applied voltage using our microdisplacement sensor, we reduce the effect of the hysteresis, and the variation in position decreased to 1.9  $\mu\text{m}$ .

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