Sensors and Materials, Vol. 23, No. 7 (2011) 449–463
MYU Tokyo

S & M 0858

Angular Velocity Sensor Using Winking Phenomenon in Solid-State Ring Resonator

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(Received April 25, 2011; accepted June 23, 2011)

Key words: winking phenomenon, ring laser gyroscope, semiconductor optical amplifier

In this paper, we describe a novel type of ring laser gyroscope (RLG) using the winking phenomenon. Conventional sensing methods of gyroscopes are categorized into vibrating-type gyroscopes using the Coriolis force and optical-type gyroscopes using the Sagnac effect. The novel type of gyroscope presented here utilizes the winking phenomenon. The winking phenomenon is intensity changes of circulatory counter propagating lasers with an applied angular velocity. The advantage is that the intensity change caused by the winking phenomenon is more than 100 times larger than the capacitance change of conventional gyroscopes in micro-electromechanical systems (MEMS) technology. The detecting circuits for the winking phenomenon become simple compared with the vibrating MEMS gyroscope, because the circuits of the MEMS gyroscopes should detect a capacitance change of 1.5×10^{-4} %/deg/s, which corresponds to 0.7 aF/deg/s. The novel RLG using the winking phenomenon does not have a dead-band because the intensity changes are linearly observed at a small to middle angular velocity. Thus, a mechanical dither is not required like in a conventional RLG using a He-Ne laser. In the experiments, an RLG including a semiconductor optical amplifier (SOA), mirrors, and beam splitters is assembled to observe the winking phenomenon. The basic characteristics of laser intensity vs. injection current and wavelength spectra were confirmed and the winking phenomenon was observed when an angular velocity was applied to the RLG. We observed that the change in laser intensity is 1.9×10^{-2} %/deg/s.

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