An Optimized Dual-Axis Electrolytic Tilt Sensor

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Fast-responding tilt measurement devices have found an increasingly wide range of applications, including electronic products, robots, automobiles, ships, missiles, communication radars, as well as aerospace and biomedical industries [1]. The growing demand for its use in different systems has extended the scope of tilt sensor research relating to its sensitivity, size, weight, power capacity, cost, and around-axis miniature feasibility. Various micro electro-mechanical-system (MEMS) tilt sensors based on piezoelectricity, capacitive load, electrolysis, force balance, and other capabilities have been previously reported. MEMS electrolytic tilt sensors, for their distinctive geometric configuration and strictly limited size, are considered to be among the ones with the highest bias stability. Moreover, electrolytic tilt sensors feature a wide angular range and a highly accurate performance.

In this study we proposes an electrolytic tilt sensor comprising a containment vessel that consists of: a) two identical polydimethylsiloxane (PDMS) hemispheres, b) two detecting electrodes formed of copper tape, and c) one common electrode made of stripe-type copper tape that is suspended in the lower portion of the hemisphere (as shown in Fig. 1). The proposed tilt sensor is able to measure dual-axis angular rates through the two detecting electrodes and the common electrode. As the detecting electrodes are partially immersed in the electrolyte, the output signal is thus induced by the change of their immersed surface areas.

A UV sensitive polymer drop was first placed upon a hydrophobic substrate and hardened by soft lithography. Afterwards, the PDMS hemispherical cavity was fabricated using the hardened polymer as template [2]. The detecting electrodes were then embedded in the walls of the PDMS vessel and placed in diametrical opposition. The common electrode was suspended in the middle. After sealing together the two PDMS sections, electrolyte was injected into the PDMS cavity with a syringe. In Fig. 2, the sensor is connected to an electrical circuit, *Wheatstone bridge*, to measure the output voltage as a function of the tilt angle on two axes. The experiment result, as shown in Fig. 3, reveals that the proposed electrolytic tilt sensor can measure an inclination angle within the range of ±180 degrees and produce a quite linear output voltage as a function of inclination angle. The fabricated device also shows good repeatability in multiple measurements. The fabrication and characterization of the improved electrolytic tilt sensor will be reported in detail.

REFERENCES

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[2] Hong J-S, Lee J-H and Nam Y-W, Carbon, 61 (2013) 577–84

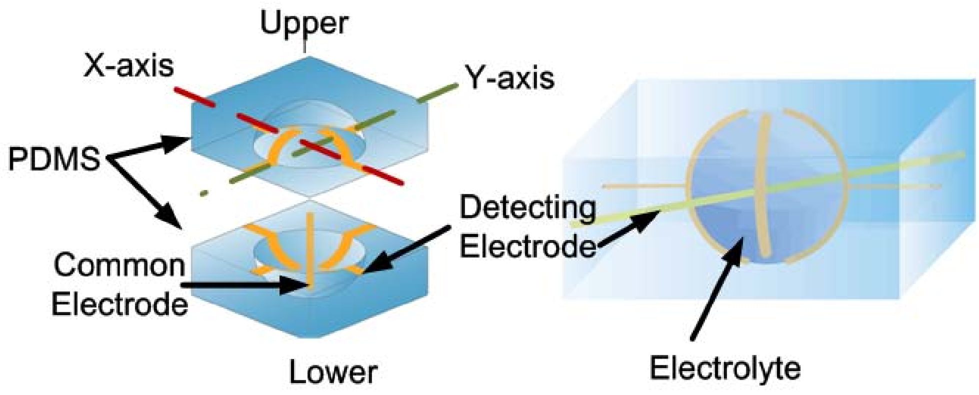

Fig. 1. A schematic diagram of the proposed electrolytic tilt sensor.

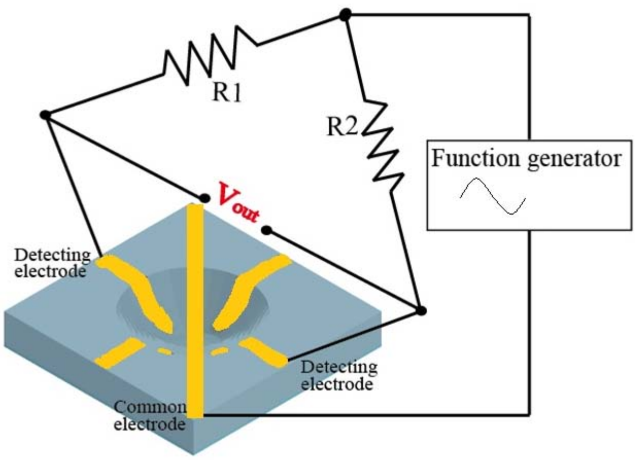

Fig. 2. A schematic of Wheatstone bridge circuit connection to the sensor electrode to measure the output signal.

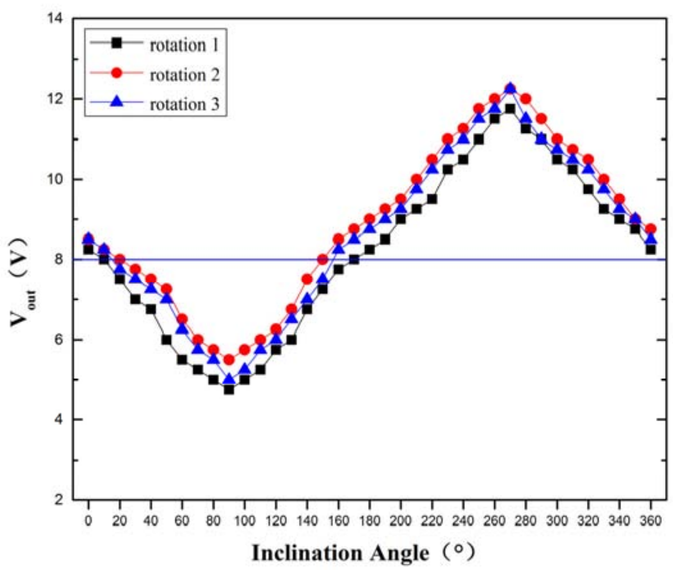

Fig. 3. The measured output voltage as a function of tilt angle for the tilt sensor.