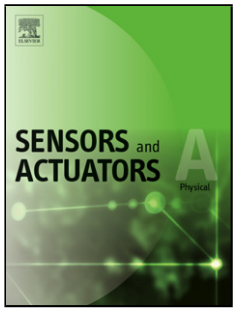

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PII: S0924-4247(16)31223-7
DOI: http://dx.doi.org/10.1016/j.sna.2017.08.016
Reference: SNA 10270

To appear in: *Sensors and Actuators A*

Received date: 29-12-2016
Revised date: 24-7-2017
Accepted date: 5-8-2017

Please cite this article as: Yoshihiro Hasegawa, Chiaki Okihara, Takayuki Yamada, Kai Komatsubara, Koji Iwano, Yasuhiko Sakai, Mitsuhiro Shikida, Smooth-surfaced flexible wall shear stress sensor fabricated by film transfer technology, Sensors and Actuators: A Physicalhttp://dx.doi.org/10.1016/j.sna.2017.08.016

Smooth-surfaced flexible wall shear stress sensor fabricated by film transfer technology

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Highlights

- ・Flexible wall shear stress sensor fabricated by film transfer technology is proposed.
- ・We fabricated three types of sensors with film thickness of 0.5, 1.0, 3.0 μm.
- ・The sensor has high spatial and temporal resolution thanks to thin film structure.
- ・We evaluated a dynamic response and a static characteristic of the sensors.

Abstract

We propose a smooth-surfaced flexible wall shear stress sensor fabricated by a newly developed thin film transfer technology to reveal the state of wall turbulence. This sensor consists of thin film types of thermal shear stress sensors and a PDMS (polydimethylsiloxane) mold structure. The sensor has a high spatial and temporal resolution comparable to that of the turbulence change because the micro-heaters of the sensing element were fabricated on thin parylene film less than 3 μm thick to reduce heat capacity, and a cavity for heat insulation was formed under the heaters. The sensor can precisely measure the wall shear stress thanks to the smooth sensor surface. In this study, we established the sensor fabrication process by using film transfer technology, and we fabricated three types of sensors with film thicknesses of 0.5, 1.0, and 3.0 μm in order to confirm the change in response characteristics due to the differences in film thickness. We evaluated the response characteristics and the shear stress detection function of the fabricated sensors. As a result, the cut-off frequency became faster as the film sensor thickness became thinner—it was 1221 Hz with a 0.5-μm thick sensor. In addition, the square of the sensor output E^2 was proportional to the shear stress to the 0.85-th power $\tau^{0.85}$.

Keywords— Shear stress sensor, Flexible sensor, Smooth-surface sensor, Flow sensor