Analysis of optical detection of ultrasound using PDMS thin film

Chayanisa Sukkasem, Suvicha Sasivimolkul, Phitsini Suvarnaphaet, and Suejit Pechprasarn*

College of Biomedical Engineering, Rangsit University, Pathum Thani, Thailand
*Corresponding author; E-mail: suejit.p@rsu.ac.th

Abstract

Medical diagnosis and treatments via ultrasound imaging have been challenged to developed using optical detection for sensing signals. The original technique employs a piezoelectric transducer to convert the mechanical energy to electrical energy during creating and sensing the ultrasound signal. However, this technique has some limitations in sensitivity, detection bandwidth, and temperature sensitivity. Herein, we report the simulation results of the optical detection of ultrasonic waves using elastic thin-film material made of polydimethylsiloxane (PDMS). The thickness in the micro-scale of the uniform layer of PDMS at 20 μm thick was observed at the 2 MHz of ultrasonic frequency, showing the PDMS displacement changed linearly by 4.6×10^{-13} m·Pa^{-1}. The response can be detected using the optoacoustic technique with the light at 685 nm wavelength. As the PDMS thickness changed, the responses of light shifted in reflectance and phases, reported the sensitivities of 5.6×10^{-7} Pa^{-1} and 1×10^{-4} rad·Pa^{-1}, respectively. Compared with the traditional detections, the PDMS optical detection using the phase shift achieved much higher sensitivity about 30 times while the detection using the reflectance shift found lower sensitivity 5 times. Nevertheless, the microscale optical sensor's advantage in this work could be an alternative technique because its implementation can be fabricated simpler than traditional sensors and does not require complicated processes.

Keywords**:** *optical detection; optical sensor; optoacoustic technique; PDMS; ultrasound detection; ultrasonic wave.*