Measurement of continuous water-level using gallium nitride ultraviolet sensor

Jaebum Sung[1,2], Hongyun So[1,2,*]

[1]Department of Mechanical Engineering, Hanyang University, Seoul 04763, Republic of Korea
[2]Institute of Nano Science and Technology, Hanyang University, Seoul 04763, Republic of Korea

[*]Corresponding author: hyso@hanyang.ac.kr

1. Introduction

Measurement of the water level have been applied in many fields. The important part of the water level measurement is stability and high resolution. There are several methods for monitoring water level. Among them, The method using visible light is rapid and uncomplicated to measure [1]. However, since it is influenced by the light of the measurement environment, it can be used only in a dark environment. By using special wavelengths other than visible light, interference with visible light can be minimized.

Silicon (Si)-based photodetectors have been studied for wide wavelength range. Si devices, however, have operating limits at temperatures below 200℃ and poor durability in radiation environments [2]. This has many limitations for use in harsh environments. Gallium nitride (GaN) has emerged as a photodetector in many fields due to its stability at harsh environments [3]. Also, since GaN absorbs ultraviolet (UV) rays, it is also used as UV detector. In this study, UV detector is fabricated with GaN to make a liquid-level measuring device.

2. Experimental Methods

Fig. 1 shows a schematic of the overall measurement method for continuous water level. The GaN UV sensor is located below the water in the cylinder, and UV light (365 nm) is emitted at the center of the cylinder. The GaN UV sensor is protected by a thin layer of polydimethylsiloxane (PDMS) to prevent electrical short circuit by water.

In this study, the level is measured using the refraction of light as it passes through adjacent medium. The media used are air, water, and PDMS, and the refractive indices at 365 nm are 1, 1.34, and 1.45. The emitted UV light is refracted inwards as it passes through a medium with a high refractive index.

3. Results and Discussion

Fig. 2 shows the normalized photocurrent with respect to the water level at different emitted number of rays. The results were simulated using COMSOL Multiphysics. As the water height increased, the normalized photocurrent increased as well. This might be because more incident UV rays were focused on the sensing area by refraction as the water height increased.

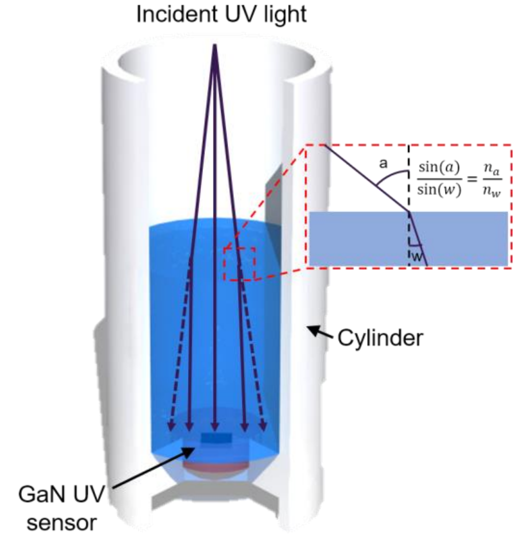

Fig.1 Schematic of the overall measurement method for continuous water level change

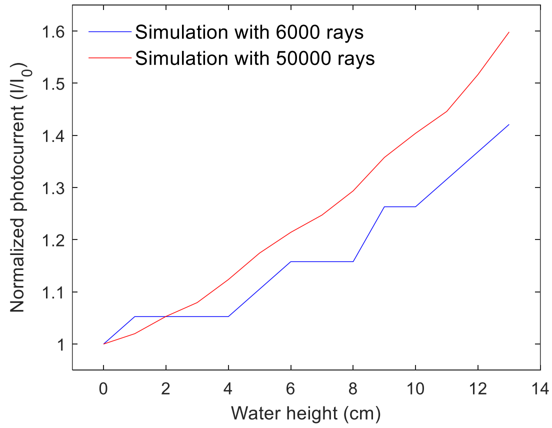

Fig. 2 Simulation of normalized photocurrent with respect to the water height. Cylinder radius: 3 cm; emission angle: 45˚; Voltage: 1V.

In addition, the responsivity showed more linear trend as the number of emitted rays increased.

4. Conclusions

The GaN-based water level sensors were designed, and the performance was predicted using computational simulation. In this study, a radius of 3 cm, emission angle of 45°, and applied bias of 1 V were used as boundary conditions. The device fabrication and experimental test will be required to demonstrate the simulated responsivity.

Acknowledgment

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