A Ring-shaped photodiode designed for use in a reflectance pulse oximetry sensor in wireless health monitoring applications - DTU Orbit (08/12/2018)

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We report a photodiode for use in a reflectance pulse oximeter for use in autonomous and low-power homecare applications. The novelty of the reflectance pulse oximeter is a large ring shaped backside silicon pn photodiode. The ring-shaped photodiode gives optimal gathering of light and thereby enable very low light-emitting diode (LED) driving currents for the pulse oximeter. The photodiode also have a two layer SiO2/SiN interference filter yielding 98% transmission at the measuring wavelengths, 660 nm and 940 nm, and suppressing other wavelengths down to 50% transmission. The photodiode has a radius of 3.68 mm and a width of 0.78 mm giving an area of 18 mm2. The capacitance of the photodiode is measured to 34.5 nF. The quantum efficiency of the photodiode is measured to 55% and 62% at 660 nm and 940 nm, respectively. It is acceptable for this prototype but can be improved. The sensor also has an on-chip integrated Au thermistor for measuring the skin temperature of the body. The thermistor has a Temperature Coefficient of Resistance of 2.7·10-3 K-1 and a repeatability on temperature measurements of ±0.26°C. The photodiode is fabricated in a clean room environment by two diffusion processes and an Advanced Silicon Etch to make the hole in the middle for the LEDs. The sensor is designed to be integrated in a sticking patch of hydrocolloid polymer together with integrated electronics, radio communication unit, and a coin cell battery. The reflectance pulse oximetry sensor is demonstrated to work in a laboratory setup with a Ledtronics dual LED with wavelengths of 660 and 940 nm. Using this setup photoplethysmograms which clearly show the cardiovascular cycle have been recorded. The sensor is shown to work very well with low currents of less than 10 mA.

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