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Peltier-Driven Temperature Control for Fluorescent Sensing Platform

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Abstract

Fluorescence dyes are widely used in biomolecule detection/quantification, flow tracing reference for gases and liquids, pathogen detection, and other life science applications. However, fluorescence emission efficiency of the dyes is easily affected by several parameters, such as polarity, pH, and temperature. Therefore, it is essential to monitor and control these parameters for reliable and accurate measurements. We propose a 3D-printed copper cuvette holder (i.materialise, Belgium) joined with a Peltier-based temperature controller platform for stable reading of fluorescence emission from the dye. For demonstration of temperature effects on fluorescence efficiency, rhodamine B, which is one of the widely used fluorescence standards and probes in bioscience, was used.

For excitation, 530 nm wavelength lighting was utilized for stimulating the rhodamine B. A Peltier device was controlled with different levels of direct current (DC) to demonstrate the temperature controlling capability of the device and fluorescence efficiency of the rhodamine B was tested with a varying temperature level: 20 ºC to 80 ºC. For our device, the temperature will be monitored by temperature ICs that are attached at three different points of the copper body for uniform temperature heating of the solution in a cuvette. We have monitored the temperature distribution of the copper holder with an external temperature monitor, the DT304, and determined that the temperature is maintained to with a 5 ºC. We plan to monitor the solution temperature directly with the use of an infrared temperature sensor positioned down at the opening of the cuvette. The ambient temperature and the temperature of the opposite junction of the Peltier device will be monitored through the use of two thermocouples. An analysis of several different temperature components of the device allow for a better interpretation of what is happening in the system. Moreover, the implementation of a water-cooling apparatus will allow for a way to quickly decrease the temperature of the cuvette when desirable. These features allow for the sample to be monitored efficiently, allowing for proper stabilization techniques and the ability to fluctuate the temperature when required of an application.

In summary, we have developed an 3D-printed copper cuvette holder with a Peltier-based temperature controller platform for stable reading of fluorescence emission from the dye or fluorophore solution. Our compact temperature controller system provides viable option for any fluorometers to easily apply it for temperature stabilization during the fluorescence dye testing.

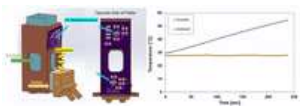

Figure 1

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