Miniaturizable 3D Printed Microfluidics Chemiluminescence System for ATP Detection in Water

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Water is important for the development and sustenance of life, and it is largely used for agricultural and industrial activities. Its quality is a fundamental condition for preserving human health. Many diseases can occur when water is contaminated by bacterial strains. This work aims to design, fabricate, and test a low-cost and miniaturizable detection system employing chemiluminescence to measure the presence of adenosine triphosphate (ATP) in water, the energy unit in biological systems. The ATP–luciferin chemiluminescent solution is introduced in a 3D printed lab-on-a-chip (LOC) microfluidics system and is faced with a silicon photomultiplier (SiPM) for highly sensitive and real-time detection. The SiPM is a solid-state photodetector consisting of a two-dimensional array of microcells, each one composed of a single photon avalanche diode (SPAD) associated with a series of quenching resistors. This configuration allows the detector to operate in Geiger mode. It is characterized by high gain, high quantum efficiency, high speed, simple output electronics, low operating voltage, and single photon sensitivity, useful for the detection of very low photon fluxes. The obtained results are shown and compared with the performances provided by other detection systems employing ATP assay. The advantages are discussed, along with optimization procedures.