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A Portable Biosensor for 2,4-Dinitrotoluene Vapors

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Abstract:

Buried explosive material, e.g., landmines, represent a severe issue for human safety all over the world. Most explosives consist of environmentally hazardous chemicals like 2,4,6-trinitrotoluene (TNT), carcinogenic 2,4-dinitrotoluene (2,4-DNT) and related compounds. Vapors leaking from buried landmines offer a detection marker for landmines, presenting an option to detect landmines without relying on metal detection. 2,4-Dinitrotoluene (DNT), an impurity and byproduct of common TNT synthesis, is a feasible detection marker since it is extremely volatile. We report on the construction of a wireless, handy and cost effective 2,4-dinitrotoluene biosensor combining recombinant bioluminescent bacterial cells and a compact, portable optical detection device. This biosensor could serve as a potential alternative to the current detection technique. The influence of temperature, oxygen and different immobilization procedures on bioluminescence were tested. Oxygen penetration depth in agarose gels was investigated, and showed that aeration with molecular oxygen is necessary to maintain bioluminescence activity at higher cell densities. Bioluminescence was low even at high cell densities and 2,4-DNT concentrations, hence optimization of different prototypes was carried out regarding radiation surface of the gels used for immobilization. These findings were applied to sensor construction, and 50 ppb gaseous 2,4-DNT was successfully detected.

Keywords: biosensor, landmine detection, chemical vapor signature, biological sensor, bioluminescence, explosive material