A Quantitative Analysis of a Paper-Based, Laser-defined, Oxygen-Generating Platform for Chronic Wounds

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Chronic wounds affect 6.5 million patients a year while consuming US$25 billion in health care costs (Sen 2009 Wound Repair Regen.). Despite advances in wound management therapies, modern treatment for chronic wounds still requires continual professional attention and expensive equipment, posing serious practical and financial burdens for the regular patient. To provide an alternative solution, we are developing a low-cost smart bandage platform that integrates actuators and sensors to monitor and treat chronic wounds. One component of the integrated platform is an oxygen-generating module. It is a polydimethylsiloxane (PDMS) based microfluidic device fabricated on a parchment paper substrate that generates oxygen via the decomposition of hydrogen peroxide in the presence of manganese dioxide, a catalyst. To optimize oxygen delivery, we are evaluating catalyst washout rate and permeation of oxygen across the paper substrate at various hydrogen peroxide inlet flow rates. We designed and fabricated a closed test fixture to monitor the release of molecular oxygen from the decomposition reaction using a commercial optical oxygen sensor. As the amount of deposited catalyst is kept constant between different inlet flow rates, the changes in oxygen concentration as a function of time reflect the behavior of catalyst reaction. Our experimental results reveal that oxygen permeation is inversely related to inlet flow rate with greater oxygen permeation at lower flow rates. Further experimentation will be conducted to evaluate the effects of long-term exposure (3-5 days) of the paper substrate to hydrogen peroxide.