A Flexible Smart Wound Dressing with Integrated On-Demand O_2-Release and Sensing Capability

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Chronic non-healing wounds impact over 6.5 million Americans per year, costs in excess of $25 billion to treat on an annual basis, and are on the rise due to increasing levels of obesity and diabetes. Current treatments are expensive, labor intensive, and generic, relying on regular cleaning, debridement, and topical or systemic administration of antibiotics. A major healing inhibitor in chronic wounds is suboptimal oxygenation of the wound bed. Unlike acute injuries that receive sufficient oxygen via a functional blood vessel network, chronic wounds often suffer from the lack of a proper vascular network; thus being incapable of providing sufficient oxygen for tissue growth. Modern medical treatment of hypoxic chronic wounds typically employs hyperbaric oxygen therapy, which requires bulky equipment and often exposes large areas of the body to unnecessarily elevated oxygen concentrations that can damage healthy tissue. A more practical approach is topical oxygen therapy (TOT) in which the dressing itself can generate the required oxygen (Figure 1). As a first step toward development of a smart dressing for chronic wounds, we propose to integrate oxygen delivery and sensing onto a single low-cost, manufacturable, flexible dressing. This dressing is fabricated on a biocompatible paper substrate that incorporates patterned catalytic oxygen generating regions and an array of oxygen sensors. The use of paper provides structural stability and flexibility while simultaneously offering printability, selective gaseous filtering, and physical/chemical protection. Our team (Purdue University, Western Michigan University, Indiana University School of Medicine, and Integra LifeSciences Corporation) is addressing the major challenges of device design, integration of oxygen generator and sensor, as well as bench-top characterization of the printed smart wound dressing system. These include employing roll-to-roll and inkjet printing processes for the fabrication of the flexible and conformal system, producing samples for testing as well as perform print images quality and morphological characterization, and performing initial in-vitro (cultured skin cells) and in-vivo (animal wound models) tests on fabricated dressing prototypes. These are achieved with a close collaboration with Integra LifeSciences throughout the device design and product development cycle, advising and guiding us on assessing risk management, understanding FDA standards compliance, creating testbeds, prototyping, bench verification and testing.

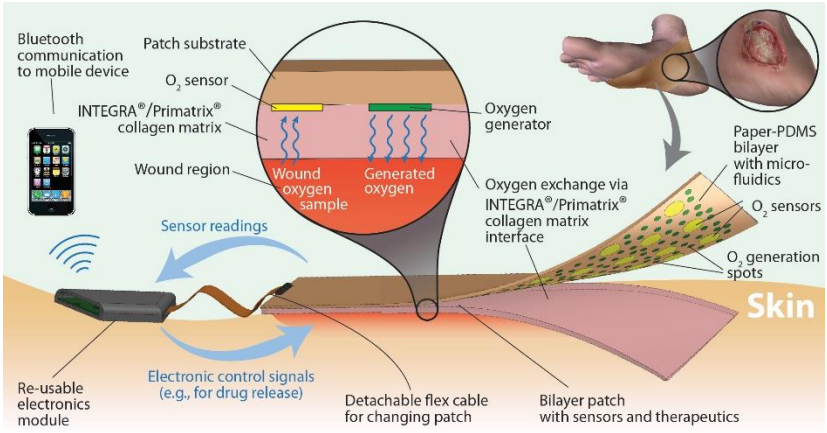

Figure 1: Illustration of a smart oxygen generation and sensing patch for management of chronic wounds.