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Non-invasive transdermal two-dimensional mapping of cutaneous oxygenation with a rapid-drying liquid bandage

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Abstract: Oxygen plays an important role in wound healing, as it is essential to biological functions such as cell proliferation, immune responses and collagen synthesis. Poor oxygenation is directly associated with the development of chronic ischemic wounds, which affect more than 6 million people each year in the United States alone at an estimated cost of $25 billion. Knowledge of oxygenation status is also important in the management of burns and skin grafts, as well as in a wide range of skin conditions. Despite the importance of the clinical determination of tissue oxygenation, there is a lack of rapid, user-friendly and quantitative diagnostic tools that allow for non-disruptive, continuous monitoring of oxygen content across large areas of skin and wounds to guide care and therapeutic decisions. In this work, we describe a sensitive, colorimetric, oxygen-sensing paint-on bandage for two-dimensional mapping of tissue oxygenation in skin, burns, and skin grafts. By embedding both an oxygen-sensing porphyrin-dendrimer phosphor and a reference dye in a liquid bandage matrix, we have created a liquid bandage that can be painted onto the skin surface and dries into a thin film that adheres tightly to the skin or wound topology. When captured by a camera-based imaging device, the oxygen-dependent phosphorescence emission of the bandage can be used to quantify and map both the pO_2 and oxygen consumption of the underlying tissue. In this proof-of-principle study, we first demonstrate our system on a rat ischemic limb model to show its capabilities in sensing tissue ischemia. It is then tested on both *ex vivo* and *in vivo* porcine burn models to monitor the progression of burn injuries. Lastly, the bandage is applied to an *in vivo* porcine graft model for monitoring the integration of full- and partial-thickness skin grafts.

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