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Bioelectronic Smart Bandage For Controlling Wound pH through Proton Delivery

Tech ID: 33815 / UC Case 2022-836-0

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INVENTORS

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OTHER INFORMATION

KEYWORDS

bioelectronics, bioelectronic bandage, wound, wound healing, bandage, smart bandage, chronic wounds, dermal, skin, dressing, macrophage, macrophages

CATEGORIZED AS

- **Medical**
  - Delivery Systems
  - Devices
  - Diagnostics
  - Disease: Dermatology
  - Therapeutics
- **Sensors & Instrumentation**
  - Medical

RELATED CASES

2022-836-0

BACKGROUND

Precise control of wound healing depends on physician's evaluation, experience. Physicians provide conditions and time for body to either heal itself, or to accept and heal around direct transplantations, and their practice relies a lot on passive recovery. Slow healing of recalcitrant wounds is a known persistent problem, with incomplete healing, scarring, and abnormal tissue regeneration. 23% of military blast and burn wounds do not close, affecting a patient's bone, skin, nerves. 64% of military trauma have abnormal bone growth into soft tissue. While newer static approaches have demonstrated enhanced growth of non-regenerative tissue, they do not adapt to the changing state of wound, thus resulting in limited efficacy.

TECHNOLOGY DESCRIPTION

To overcome these challenges, a research team at UC Santa Cruz (UCSC) has developed a more intelligent system and related devices and methods to control tissue regeneration towards better wound healing processes. UCSC's Bioelectronics for Tissue Regeneration (BETR) aims to establish bidirectional communication between body and a bioelectronic interface that will guide and expedite tissue healing and regeneration. BETR's dynamic, adaptive closed-loop architecture guides tissue along an optimal growth pathway. The custom hardware uses wearable biochemical and biophysical sensors to precisely determine current and wound states and actuators to deliver biochemical and biophysical interventions at relevant time points. Custom optics, software, and supporting logic is the adaptive learning system that connects camera, sensors, and actuators for optimal and directed temporal and spatial response. BETR's evolving aims include the detection of predictive biomarkers to better assess healing and non-healing wound states, which factors into data-driven, closed-loop feedback controls.

This case's subject matter focuses on a device capable of delivering multiple ions and biomolecules using an electric field, and in particular, using sustained charge (e.g., proton) delivery for providing treatment (e.g., changing the pH) of wound surfaces. In one example, this is achieved through the use of a device that incorporates a hydrogel-based ion pump with a custom printed circuit board for pumping ions to and from a treatment site so as to deliver and measure the specific dose of the ions delivered to treatment site. Preliminary experiments achieved delivery of approximately 6-19 nanomoles of protons to in vivo wound surfaces after ten minutes, and the M1/M2 ratio in treated models was ~36% lower than untreated. The larger prototype system further entails the pumping device coupled to a camera forming images of the wound, wherein the control circuit provides closed loop control of the pumping based on healing of the wound observed in the images. Overall advantages of this newer approach include closed loop control of sensing and actuation, accelerating wound healing through dry delivery of ions and biomolecules, and programmable wireless actuation of device to deliver over a period time e.g., several days.

APPLICATIONS

- diagnostics – wound healing
- therapeutics – wound healing

FEATURES/BENEFITS

- adaptive closed-loop to guide tissues along an optimal growth pathway
- customizable 3D printed molds based on scalable polydimethylsiloxane (PDMS)
- integrated electrophoretic ion pump for more precise and temporal dosing

INTELLECTUAL PROPERTY INFORMATION

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Published Application	WO 2023/196125	10/12/2023	2022-836

Additional Patent Pending

RELATED MATERIALS

- Selberg, J., Jafari, M., Mathews, J., Jia, M., Pansodtee, P., Dechiraju, H., Wu, C., Cordero, S., Flora, A., Yonas, N., Jannetty, S., Diberardinis, M., Teodorescu, M., Levin, M., Gomez, M. and Rolandi, M. (2020), Machine Learning-Driven Bioelectronics for Closed-

Loop Control of Cells. Adv. Intell. Syst., 2: 2000140. - 09/24/2020

- X. Strakosas, J. Selberg, Z. Hemmatian, M. Rolandi, Taking Electrons out of Bioelectronics: From Bioprotonic Transistors to Ion Channels. Adv. Sci. 2017, 4, 1600527.

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Wearable Bioelectronics for Programmable Delivery of Therapy
- A Bio-Based Manufacturing Process To Create Foam Using Chitin Sourced From Shellfish Waste

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