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Dressing for Bioelectronic Smart Bandage

Tech ID: 34585 / UC Case 2026-585-0

CONTACT

Marc Oettinger
marc.oettinger@ucsc.edu
tel: 831-502-0253.

BACKGROUND

Chronic and complex wounds represent a substantial clinical and economic burden, affecting more than 6.5 million individuals in the United States and accounting for annual healthcare expenditures exceeding $25 billion. These wounds, including those arising from trauma such as blast and burn injuries, frequently involve multiple tissue types—e.g., skin, bone, and nerve—and are often associated with delayed or incomplete closure. In certain severe trauma populations, complications such as heterotopic ossification, characterized by abnormal bone formation within soft tissue, are observed at elevated incidence. More broadly, recalcitrant wounds are characterized by impaired healing dynamics, including persistent inflammation, fibrosis, and aberrant tissue regeneration. There are barriers to effective recovery because current standards of care have several critical limitations. Most therapies are "reactive" rather than "proactive" and they fail to adapt to the wound's shifting physiological state, such as fluctuating pH or oxygen levels. Conventional devices use rigid or semi-rigid components, and this mismatch does not conform to contoured or mobile areas like the heel or joints. Moreover, semi-flexible electronics often lose contact during patient movement, and this inconsistent contact leading to sub-therapeutic dosing and persistent inflammation. Bridging this gap requires conformal, bio-integrated systems capable of sustained contact and autonomous, responsive therapeutic delivery to overcome the stagnant healing dynamics of recalcitrant wounds.

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 or a-Heal) 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 more conformable polydimethylsiloxane (PDMS)-hydrogel architecture. UCSC's BETR's / a-Heal's flexible polyimide electrode integrated with PDMS body and strategically positioned protrusions maintains conformal contact across curved anatomical sites while preventing wound smothering and ensuring gas exchange. This research results features a cuttable/scalable tessellating reservoir design, having fixed alternating reservoirs with tessellating electrode patterns which enables customization to variable wound sizes while maintaining dual-therapy control across inner and outer delivery rings. Furthermore, the double-fluted cation-selective hydrogel cured within PDMS protrusions address challenges with brittleness through mechanical interlocking rather than adhesive chemistry.

APPLICATIONS

▶ diagnostics – wound healing

▶ therapeutics – wound healing

FEATURES/BENEFITS

INVENTORS

▶ Rolandi, Marco

OTHER INFORMATION

KEYWORDS

BETR, a-Heal, bioelectronics, bioelectronic bandage, wound healing, wound, bandage, smart bandage, chronic wounds, dermal, skin, dressing, macrophage, macrophages, bioelectronics for tissue regeneration

CATEGORIZED AS

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

RELATED CASES

2026-585-0, 2026-584-0, 2022-836-0, 2023-934-0, 2025-936-0

- Current bioelectronic systems require separate devices for different wound dimensions; this research result features cuttable/scalable tessellating reservoir design to enables tailoring to variable wound sizes while maintaining dual-therapy controls.

- Represents a significant manufacturing achievement for integrating ion-exchange membranes in flexible devices.

- Conformal elastic modulus of flexible polyimide electrode integrated with PDMS body ~10-100 kPa matches wound tissue.

- Progressively-cured hydrogel layers helps address critical brittleness problem of cation-selective hydrogels (through mechanical interlocking vs. surface adhesion) and enables device flexibility essential for anatomical conformity and patient mobility.

- Preliminary porcine data shows statistically significant faster closure ($p=0.0145$) and 36.3% reduction in granulation tissue ($p<0.005$) at day 22 versus current standard of care.

RELATED MATERIALS

RELATED TECHNOLOGIES

- Portable Therapy Delivery
- Intelligent Wound Healing Diagnostics and Treatments
- Bioelectronic Smart Bandage For Controlling Wound pH through Proton Delivery
- Wearable Bioelectronics for Programmable Delivery of Therapy

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
- Portable Therapy Delivery
- Bioelectronic Smart Bandage For Controlling Wound pH through Proton Delivery