2022「中技社科技獎學金」

2022 CTCI Foundation Science and Technology Scholarship

境外生研究獎學金

Research Scholarship for International Graduate Students

Self-Powered Systems for Wound Healing and Environmental Monitoring Applications

教務處跨院國際博士班學位學程
International Intercollegiate Ph.D. Program

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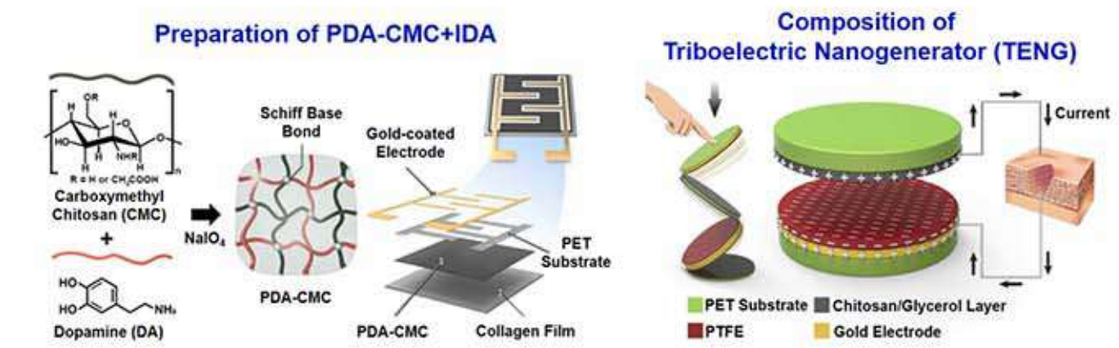
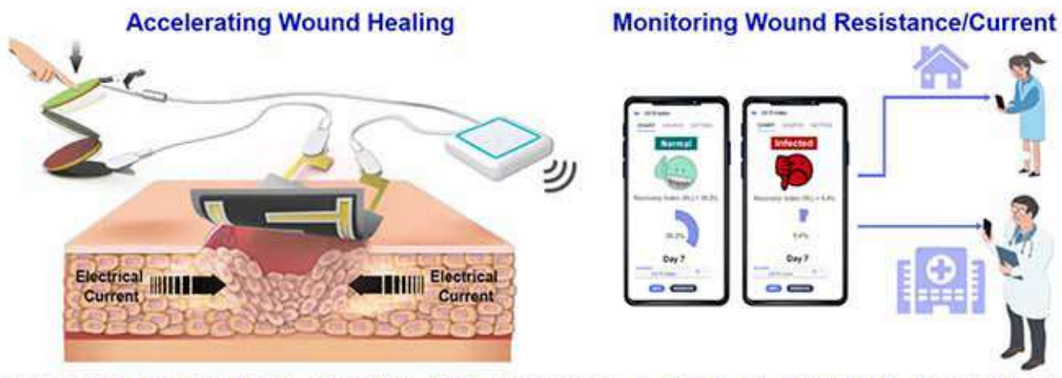
Abstract

Self-powered devices such as triboelectric nanogenerators (TENGs) have emerged as promising self-powered platforms due to their compelling characteristics such as light weight, flexibility, conformability, easy fabrication, and high energy conversion efficiency. TENGs can transform biomechanical energy from human movements into electricity, which has been used for myriad biomedical applications as a power source for medical devices and sensors. Owing to the versatile nature of TENG, it has been utilized for wound healing and chemical sensing applications. The electrical voltage from TENG have been used to effectively accelerate the wound healing. In addition, the TENG is also demonstrated as chemical sensor for detection of mercury ions which is integrated with robotic modules for automated sensing.

Research Focus

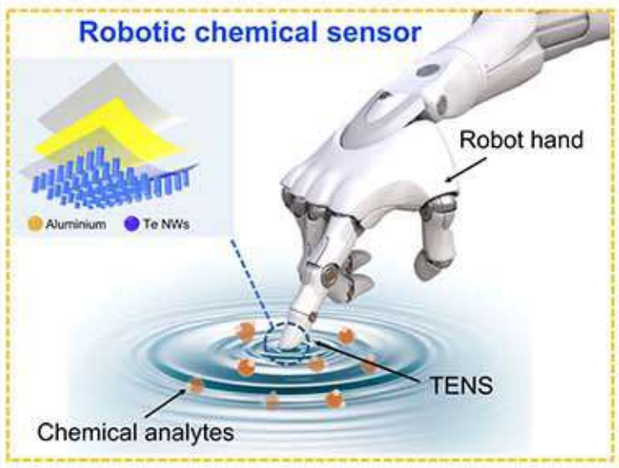
Smart electroactive dressing for wound healing and simultaneous monitoring

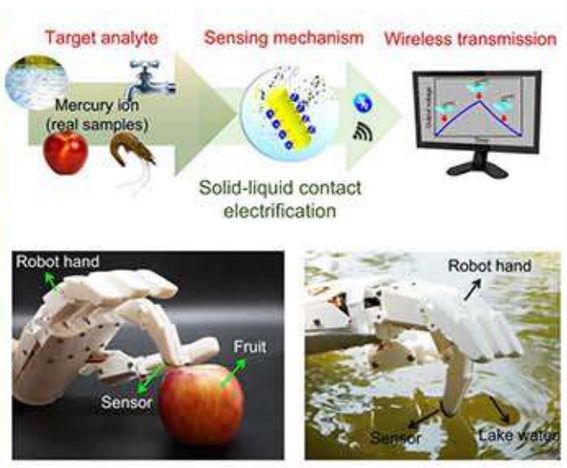




An engineered electroactive dressing that comprises a layer of PDA-CMC hydrogel and an interdigitated array (IDA) electrode was developed. The hydrogel provides a channel that transmits endogenous bioelectrical signals to the wound for accelerating the wound healing. The IDA electrode detects the electrical resistance or output current across the wounded tissue for the noninvasive real-time monitoring of the overall healing process.

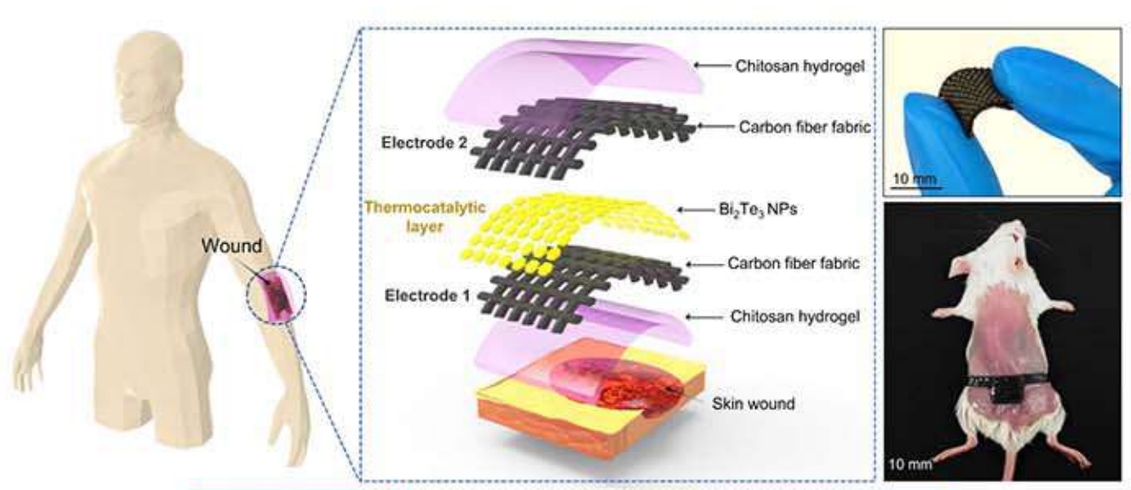
Triboelectric nanosensor integrated with robotic platform for chemical sensing

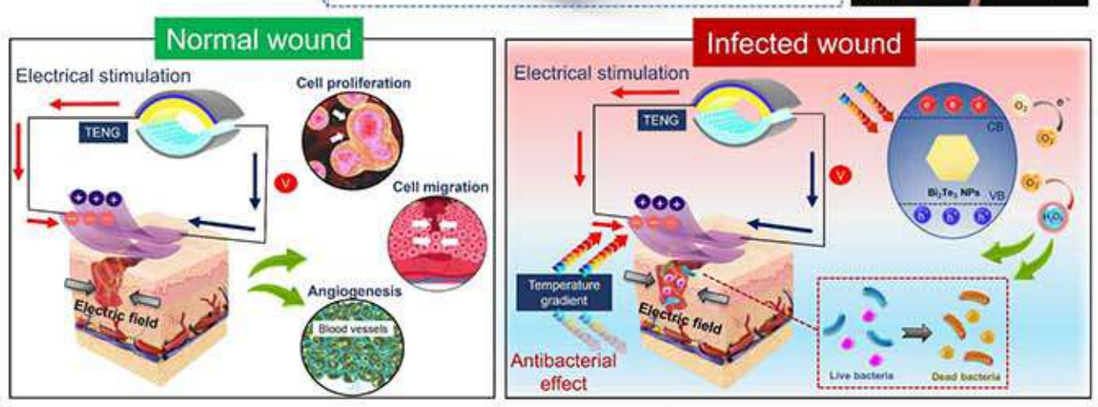


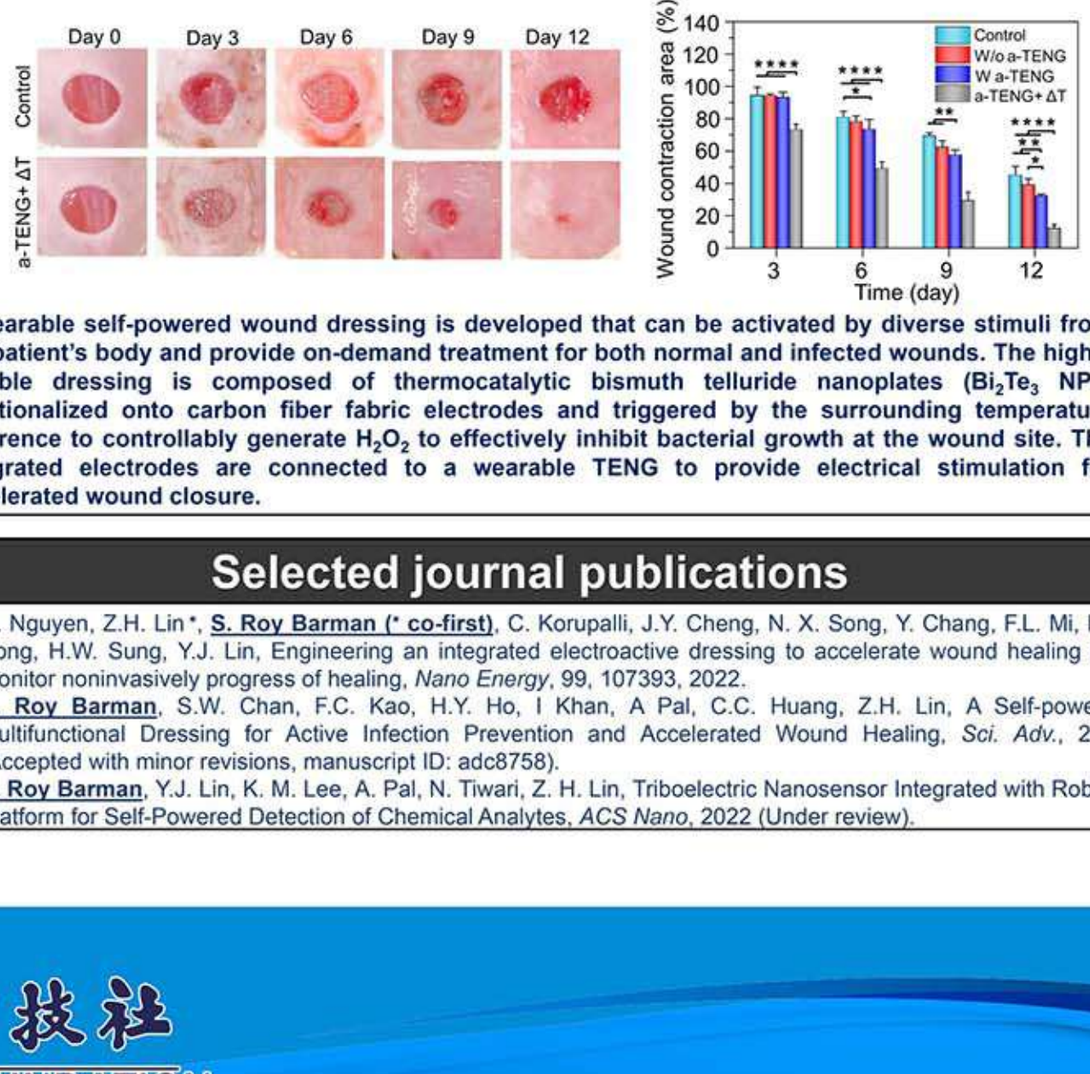


A self-powered triboelectric nanosensor integrated with a robotic hand with additional wireless transmission functionality to detect Hg^{2+} ions was developed for rapid single-step onsite detection in the resource-limited settings. The robotic hand was mounted with Tellurium nanowire arrays that served as a solid triboelectric material, which underwent periodic contact and separation with the Hg^{2+} solution, leading to the in-situ formation of HgTe NWs owing to the selective binding affinity of Te NWs toward Hg^{2+} ions.

Self-powered multifunctional dressing for infection prevention and accelerated healing







A wearable self-powered wound dressing is developed that can be activated by diverse stimuli from the patient's body and provide on-demand treatment for both normal and infected wounds. The highly tunable dressing is composed of thermocatalytic bismuth telluride nanoplates (Bi_2Te_3 NPs) functionalized onto carbon fiber fabric electrodes and triggered by the surrounding temperature difference to controllably generate H_2O_2 to effectively inhibit bacterial growth at the wound site. The integrated electrodes are connected to a wearable TENG to provide electrical stimulation for accelerated wound closure.

Selected journal publications

1. N. Nguyen, Z.H. Lin*, **S. Roy Barman (* co-first)**, C. Korupalli, J.Y. Cheng, N. X. Song, Y. Chang, F.L. Mi, H.L. Song, H.W. Sung, Y.J. Lin, Engineering an integrated electroactive dressing to accelerate wound healing and monitor noninvasively progress of healing, *Nano Energy*, 99, 107393, 2022.
2. **S. Roy Barman**, S.W. Chan, F.C. Kao, H.Y. Ho, I Khan, A Pal, C.C. Huang, Z.H. Lin, A Self-powered Multifunctional Dressing for Active Infection Prevention and Accelerated Wound Healing, *Sci. Adv.*, 2022 (Accepted with minor revisions, manuscript ID: adc8758).
3. **S. Roy Barman**, Y.J. Lin, K. M. Lee, A. Pal, N. Tiwari, Z. H. Lin, Triboelectric Nanosensor Integrated with Robotic Platform for Self-Powered Detection of Chemical Analytes, *ACS Nano*, 2022 (Under review).