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TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

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Zoom: https://gtiit.zoom.us/j/91434034614

Gas-permeable essential oil hydrogel for real-time wound monitoring and therapy

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MSc Seminar

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Chronic wounds present major healthcare challenges due to prolonged healing, increased risk of infection, and impaired tissue regeneration. To address these issues, we have developed a smart essential oil (EO) hydrogel-based wound dressing that integrates broad-spectrum antibacterial activity, immune modulation, and real-time wound monitoring.

Our approach utilizes a nano-emulsified EO encapsulated within a carboxymethyl cellulose-stabilized hydrogel, enhancing stability and enabling controlled release. The EO demonstrates strong antibacterial properties and modulates the wound immune microenvironment by shifting macrophage polarization from a pro-inflammatory (M1) to an anti-inflammatory (M2) phenotype. This transition reduces oxidative stress and promotes collagen deposition, fostering an optimal healing environment.

To improve oxygen permeability, we engineered a macroporous hydrogel scaffold through mechanical foaming, optimizing pore size and distribution. Hydrogels produced at a stirring speed of 1000 rpm achieved an optimal balance between mechanical strength, adhesion, and vapor permeability. This design prevents excessive moisture retention while maintaining adequate wound hydration, critical for efficient healing.

For real-time wound monitoring and controlled drug release, we integrated temperature sensors and flexible heaters onto a polyurethane nanofiber substrate. The fabricated sensor exhibited a highly linear response in the 30–55°C range, ensuring precise temperature tracking. Simultaneously, the hydrogel matrix enabled temperature-triggered EO release, allowing adaptive treatment based on wound conditions. Moving forward, we plan to apply this smart dressing to a diabetic mouse model to further evaluate its wound healing efficacy compared to conventional hydrogel dressings.