Soft matter based Biomimetic Wound Healing Material

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Introduction

This study aimed to develop and evaluate transparent composite nanofibrous membranes with enhanced biological functionality as advanced wound dressing materials. As shown in Figure 1, we hypothesized that the incorporation of sodium alginate (NaAlg) or zinc oxide (ZnO) into electrospun polymer nanofibers, combined with the use of a conductive aluminum mesh during fiber collection, would result in membranes with locally aligned nanofibers, enabling optical transparency, biocompatibility, and mechanical properties. By using a 1.58 mm aluminum square mesh as a fiber collector during electrospinning of poly-caprolactone (PCL)/ethylene vinyl alcohol (EVOH), we fabricated composite fiber membranes with varying concentrations of NaAlg (1-5% w/v) or ZnO (1-3% w/v).

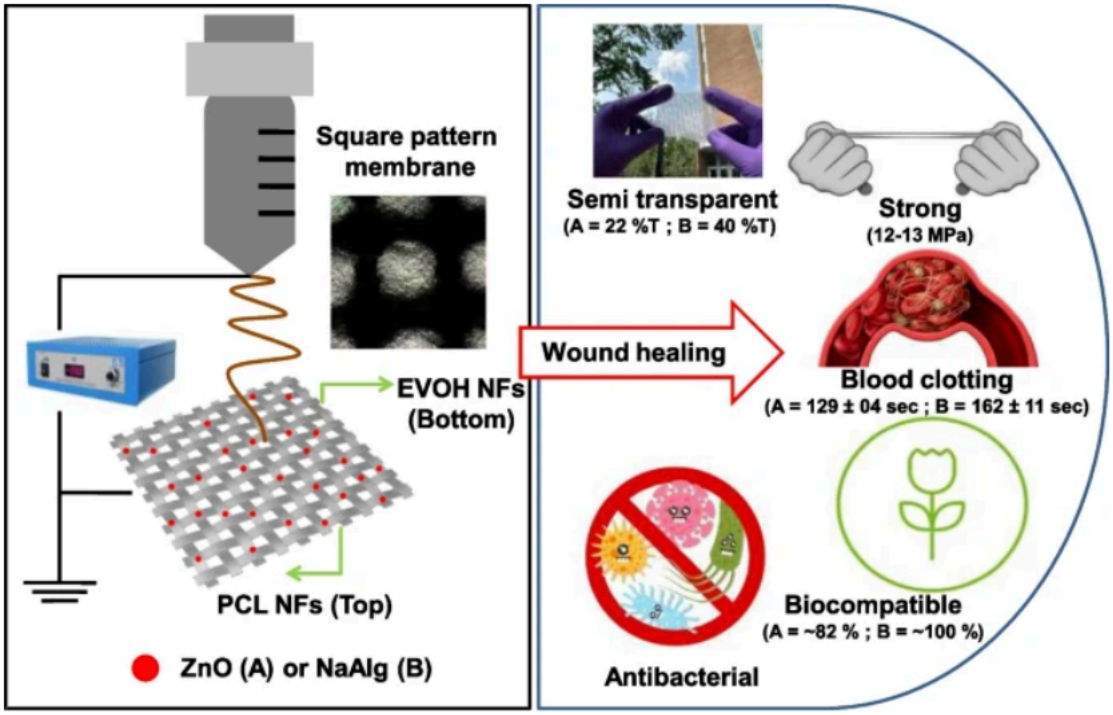

Figure 1. The schematic of electrospin process (left) and the properties(right)

Conclusion

The structure is shown in Figure 2. The use of the conductive mesh led to partial alignment of the nanofibers, enhancing light transmission and achieving notable optical transparency (up to 40% for NaAlg and 22% for ZnO). These membranes also exhibited a bi-layer structural configuration, robust mechanical properties (12–

13 MPa), and optimal water vapor transmission rates (WVTR, 1400–1700 g/m2/day) Biological assessments, including disc diffusion and cytotoxicity tests, demonstrated excellent biocompatibility (85–100% viability with HaCaT cells) and promising blood-clotting properties. These findings suggest that the developed nanofiber membranes, through their unique alignment-driven transparency and multifunctionality, can effectively monitor wound healing in real time, absorb substantial exudate, and provide a protective barrier against environmental contaminants. This work highlights the novelty and potential of these nanofiber membranes as advanced biomaterials for diverse wound dressing applications.

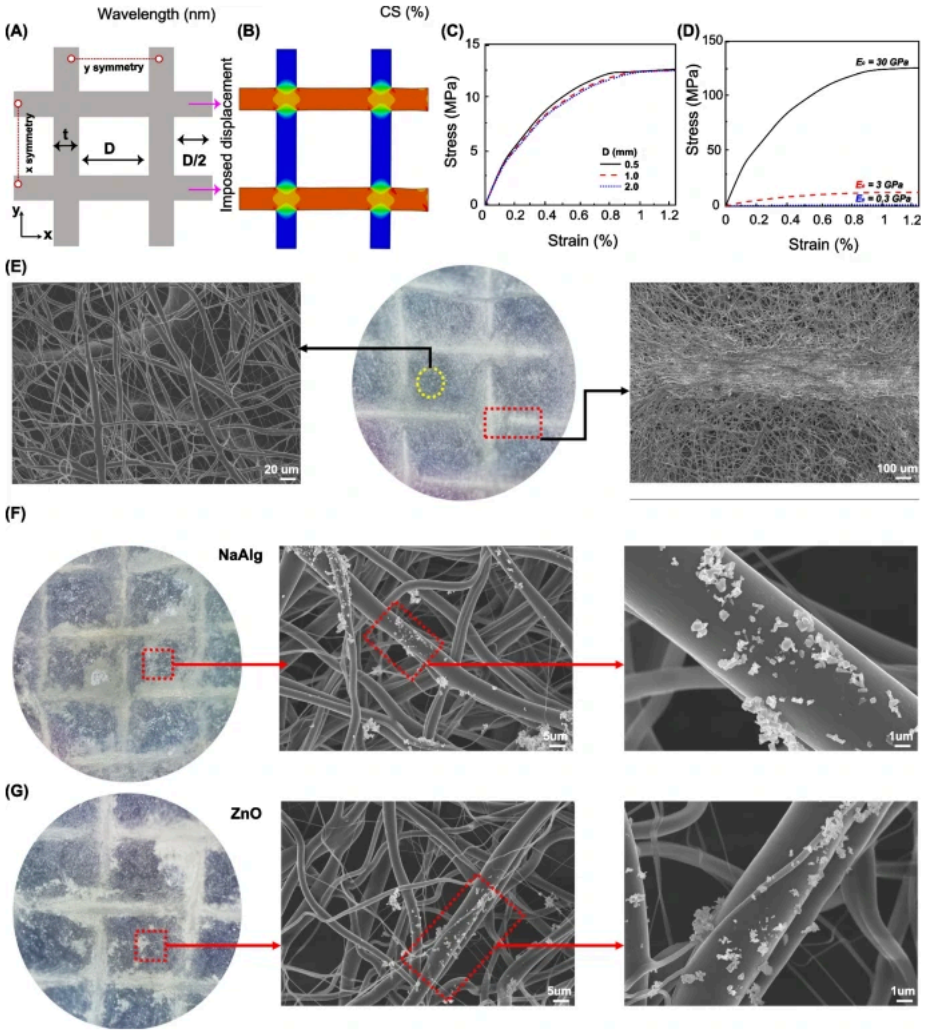

Figure 2. A, B Hypo-elastic model used to study the nonlinear behavior of the membrane under small strains, highlighting the influence of C the center space of the membrane and D Young's modulus on the mechanical strength of the membrane, FESEM and optical microscope images for the arrangement of nanofibers in E PCL/EVOH nanofiber without NaAlg and ZnO, F with NaAlg, and G with ZnO-based nanofiber

References

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