Evaluation of elastin and magnesium incorporation in electrospun chitosan membranes for skin wounds

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INTRODUCTION

Electrospun, chitosan membranes (ESCM) have seen promise in guided bone regeneration studies [1]. Chitosan can also be mixed with other polymers, like elastin, to improve mechanical properties and bioactivity, increasing its versatility [2]. Specifically, the elastin-polysaccharide nanofiber structure may serve as a template in skin tissue engineering applications.

A big challenge facing large skin defect healing is the lack of vascularization into the defect. Magnesium (Mg^{2+}) has anti-inflammatory effects and has been shown to play a role in angiogenesis [3]. The goal of this work is to evaluate incorporation of amorphous Mg^{2+}-phosphate nanoparticles (MgNP) and elastin into electrospun chitosan membranes to assess potential use in skin wound healing.

METHODS

Membrane Fabrication

The following groups of ESCMs were made to evaluate the individual components' effects; (C: chitosan, CE: chitosan-elastin, CMg: chitosan-MgNP, and CEMg: chitosan-elastin-MgNP).

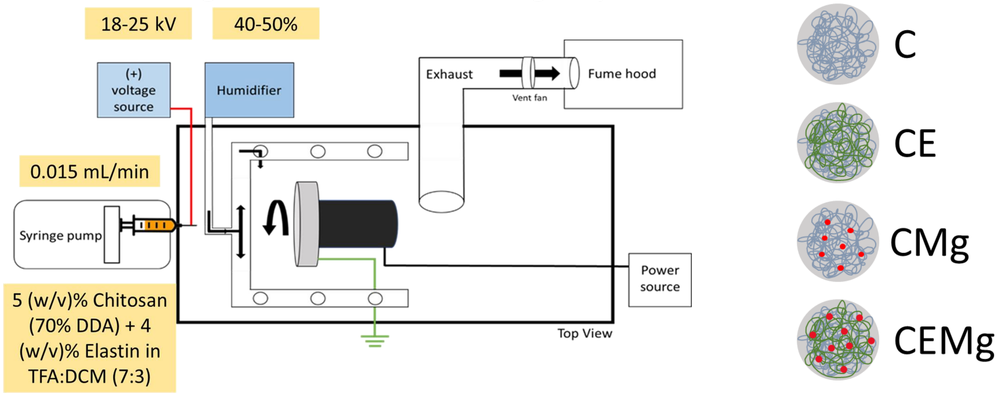

Figure 1. Top-down view of custom electrospinning apparatus (left) and representative icons for membrane groups (right).

Post-Spinning Treatment

All groups underwent a post-spinning treatment to remove residual TFA salts and attach a hydrophobic di-tert-butyl dicarbonate group to improve retention of nanofiber morphology in aqueous environments.

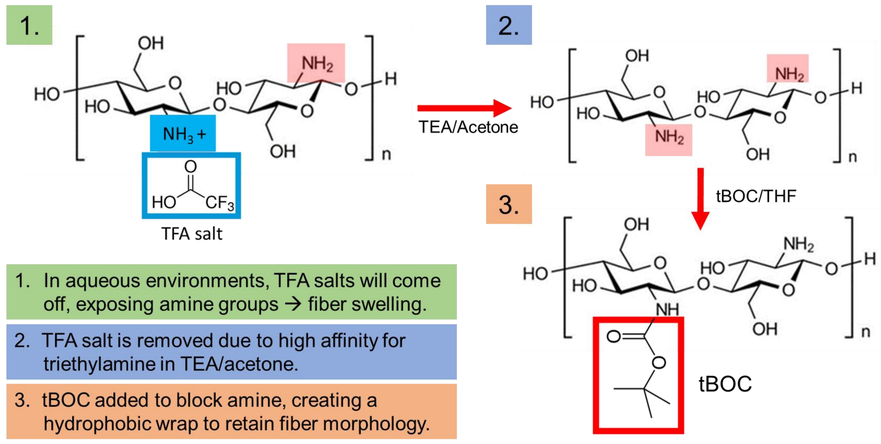

Figure 2. Schematic and explanation of post-spinning treatment reaction mechanism.

Membrane characterization and in vitro assessments

Membranes were characterized for nanofiber structure, water contact angle analysis, Mg^{2+} incorporation/*in vitro* release/cytotoxicity, elastin incorporation, mechanical properties, *in vitro* degradation profiles, and *in vitro* cytocompatibility.

RESULTS

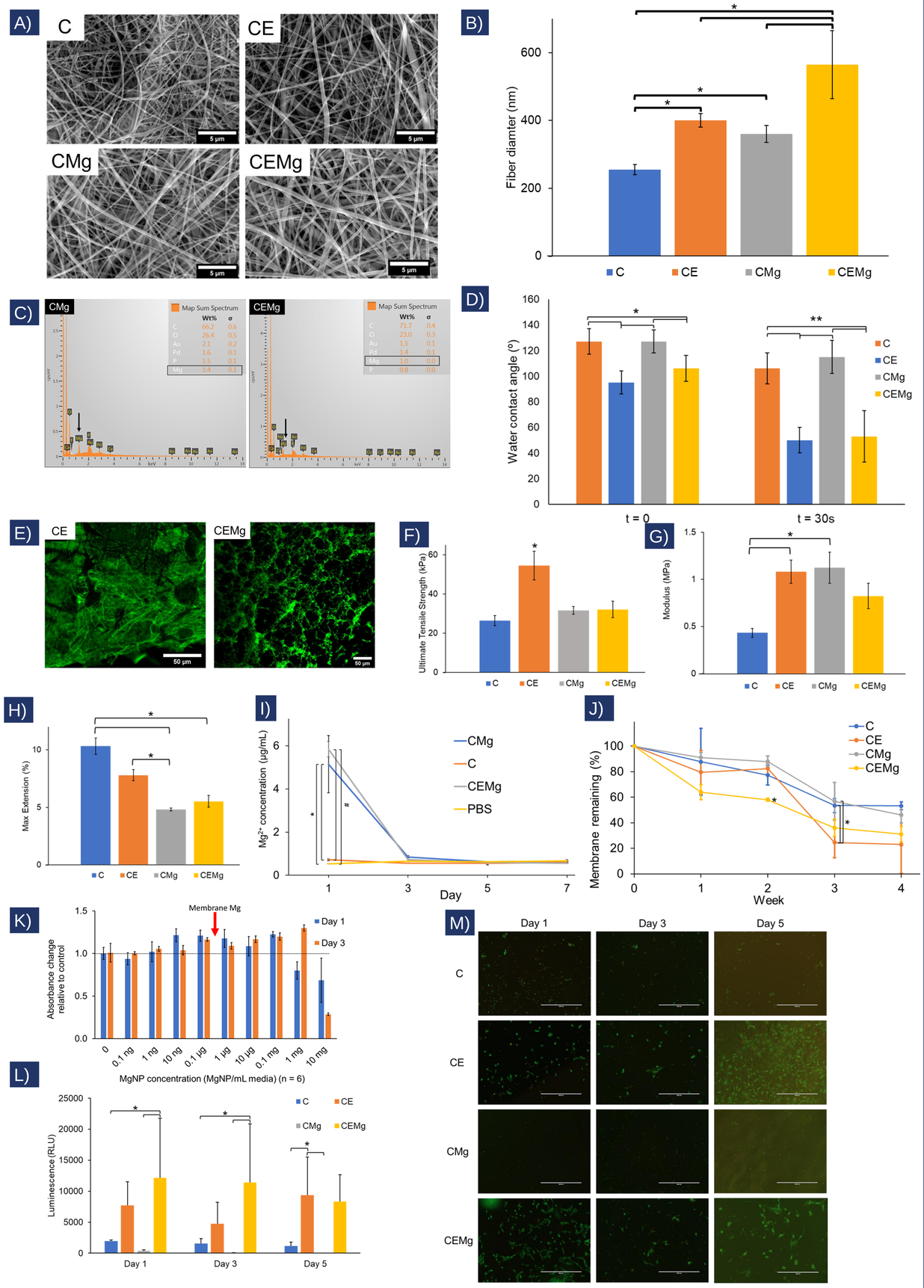

Figure 3. A) SEM images of membrane groups. B) Average fiber diameter (n = 3). C) EDS magnesium incorporation analysis. D) Water contact angle analysis (n = 3). E) Immunofluorescence images for elastin incorporation assessment. F-H) Results from mechanical testing (F) UTS, (G), Modulus, (H) Extension. I) *In vitro* magnesium release. J) *In vitro* degradation profiles. K) MgNP cytotoxicity with NIH3T3 cells. L) Cytocompatibility of membranes with NIH3T3 fibroblasts. M) LIVE/DEAD stained images of NIH3T3 fibroblasts on membranes.

CONCLUSIONS

Both elastin and MgNP have been successfully incorporated into ESCM. Elastin incorporation reduced the hydrophobicity of the membranes following post-spinning treatment and increased cytocompatibility and degradation rates.

References
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[2]H. Su *et al.* doi: 10.3390/MD19030169.
[3]D. Bernardini *et al.* doi: 10.2741/1610.

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