

Inhibition of Escherichia virus MS2, mimic of SARS-CoV-2, via essential oils-loaded nanofibers

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Introduction

In December 2019, a novel strain of coronavirus, SARS-CoV-2, was identified. Infected patients revealed symptoms of fever, cough (dry), sore throat, and fatigue, which began manifesting after 5 days of incubation. Hoping to prevent transmission, many countries adopted a mandatory mask use in closed public spaces. However, most mask options display a passive action against COVID-19. To overcome such restrictions, this work proposes the incorporation of anti-viral essential oils (EOs) loaded onto a nanofibrous layer that can be adapted to both community and commercial masks.

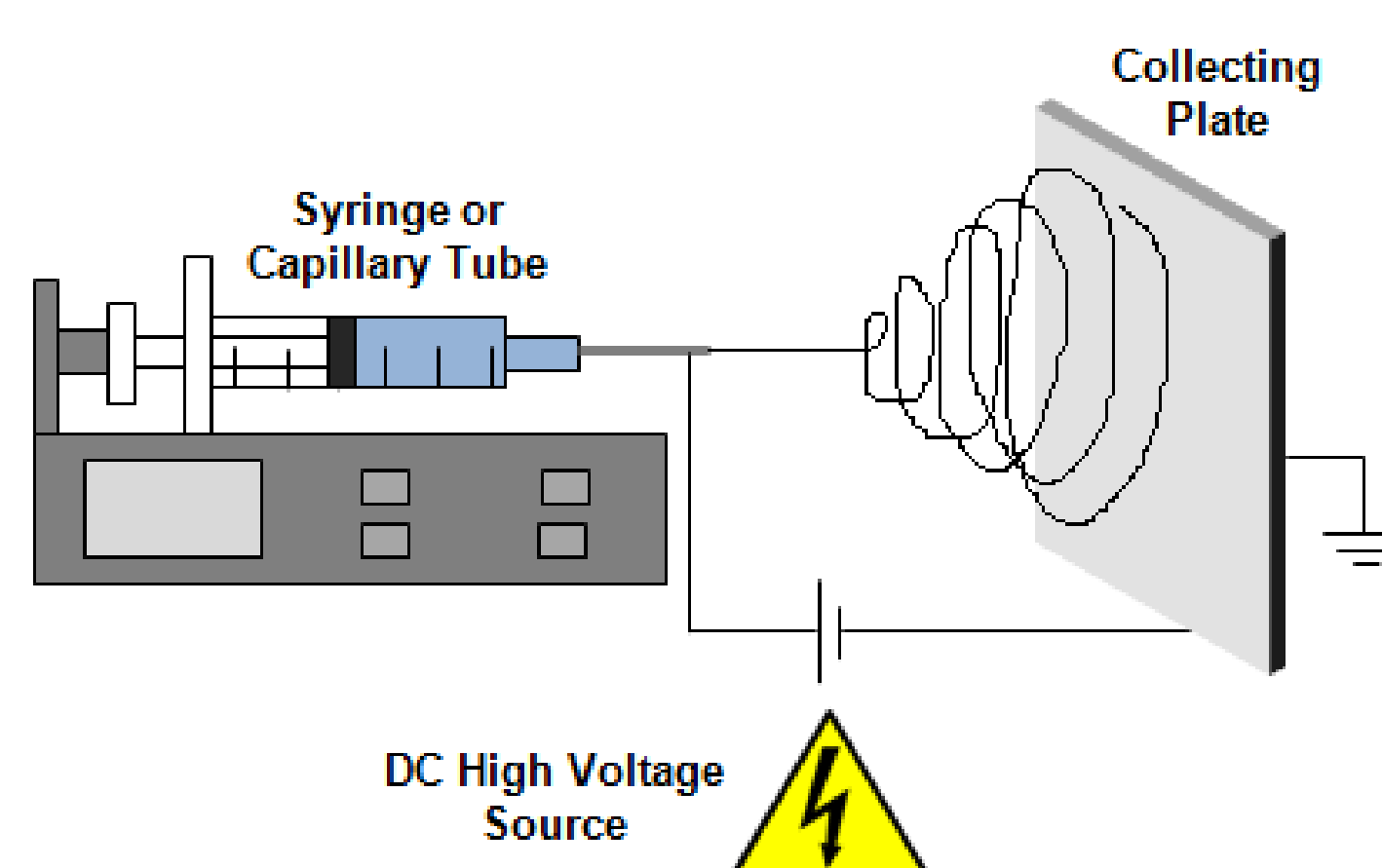
EOs Drawbacks

- cytotoxic at increased concentrations, which prevents systemic delivery;
- present low resistance to degradation by external factors (e.g., temperature, light, moisture);
- highly volatile in their free, unloaded form.

Materials and Methods

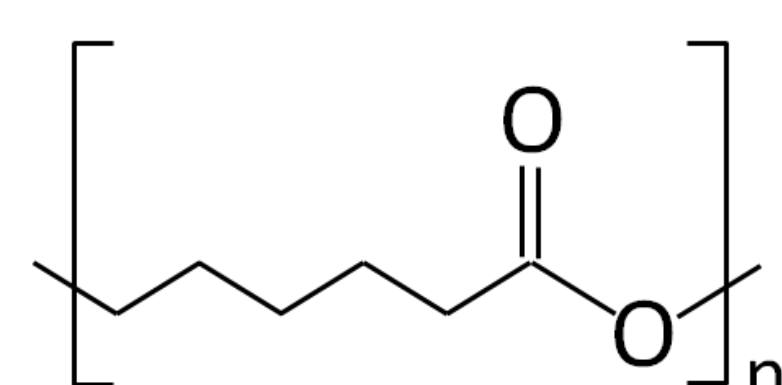
Electrospinning

Spinning technique that allows the production of continuous, homogeneous nanofibers.



Polymeric solution preparation

Polycaprolactone (PCL)



Why PCL?

- Food and Drug Administration (FDA)-approved;
- Drug loading efficiency (i.e., EOs biomolecules);
- Excellent mechanical strength, non-toxic, hydrophobic, biodegradable, etc.

PCL at 14 wt.% in chloroform/dimethyl formamide (CHF/DMF at 9/1 v/v)

Electrospinning processing conditions

Potential: 23 kV
Extruding Speed: 0.7 mL/h
Distance to Collector: 26 cm
Needle (inner diameter): 18 gauge

Essential Oils (EOs) Selection

20 EOs* with antimicrobial potential were examined for their minimum inhibitory concentrations (MICs) against the MS2 *Escherichia* host and for their virucidal concentration (VC) against the MS2 virus, mimic of SARS-CoV-2, at initial concentration of 1x10⁷ CFUs or PFUs/mL, respectively.

EOs	MICs against MS2 host (mg/mL)	VC against MS2 virus (mg/mL)
Lemongrass (LGO)	178.0	356.0
Niaouli (NO)	45.7	365.2
Eucalyptus (ELO)	>	586.0
Orchid	85.6	428.0
Tea Tree Oil	22.4	447.5
Clove	105.6	528.0

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Acknowledgments

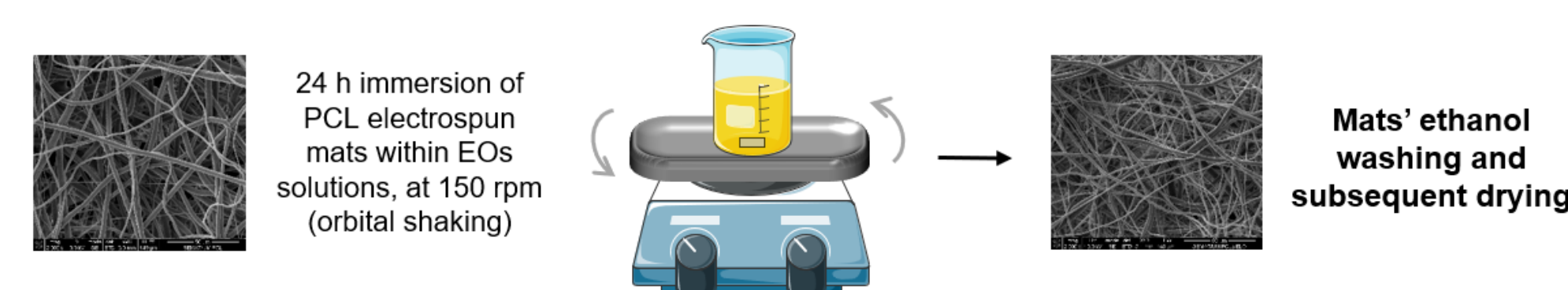
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Results and Discussion

Nanofiber Loading

Strategy 1

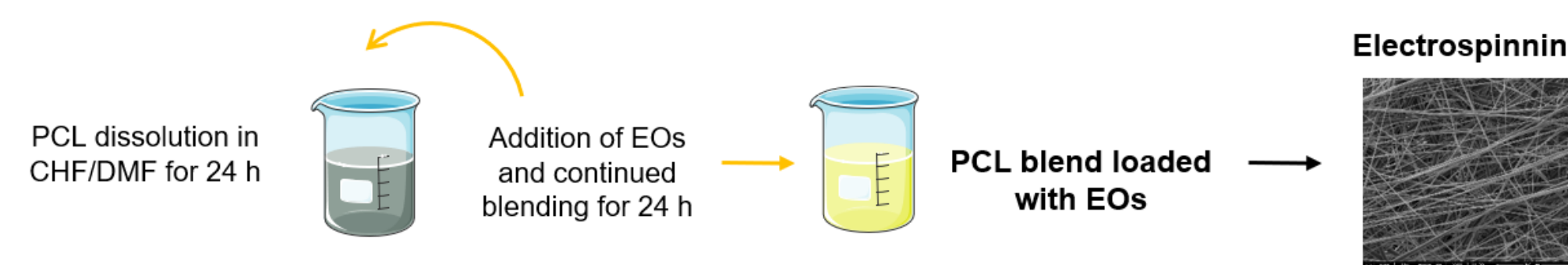
Physical adsorption of the EOs at the surface of the electrospun PCL mats (label PCLaEOs)



Loading Amount:
10% of VC

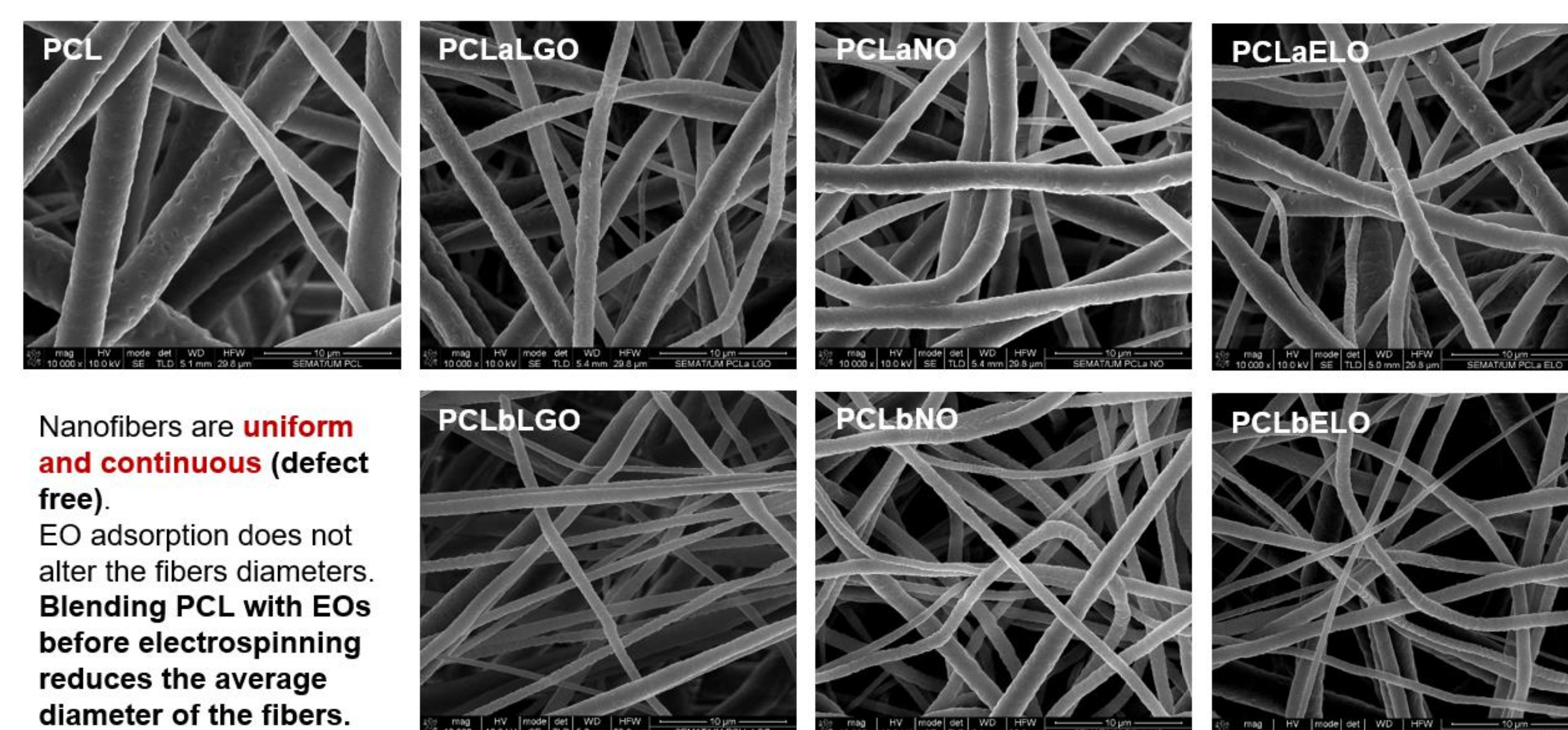
Strategy 2

Blending the PCL solution with the selected EOs (label PCLbEOs)



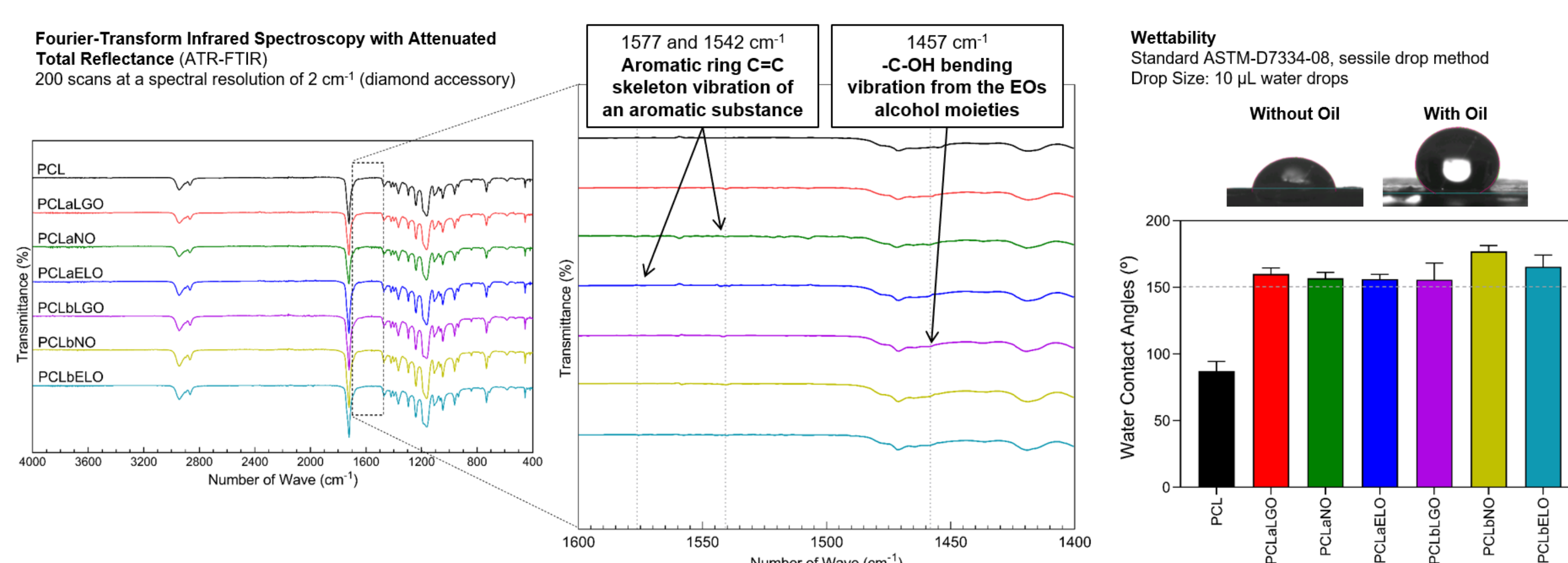
(> 10% VC turned the mats sticky and the fragrance too intense)

Nanofiber Morphology



Nanofibers are **uniform and continuous (defect free)**.
EO adsorption does not alter the fibers diameters. **Blending PCL with EOs before electrospinning reduces the average diameter of the fibers.**

Confirmation of EOs Loading

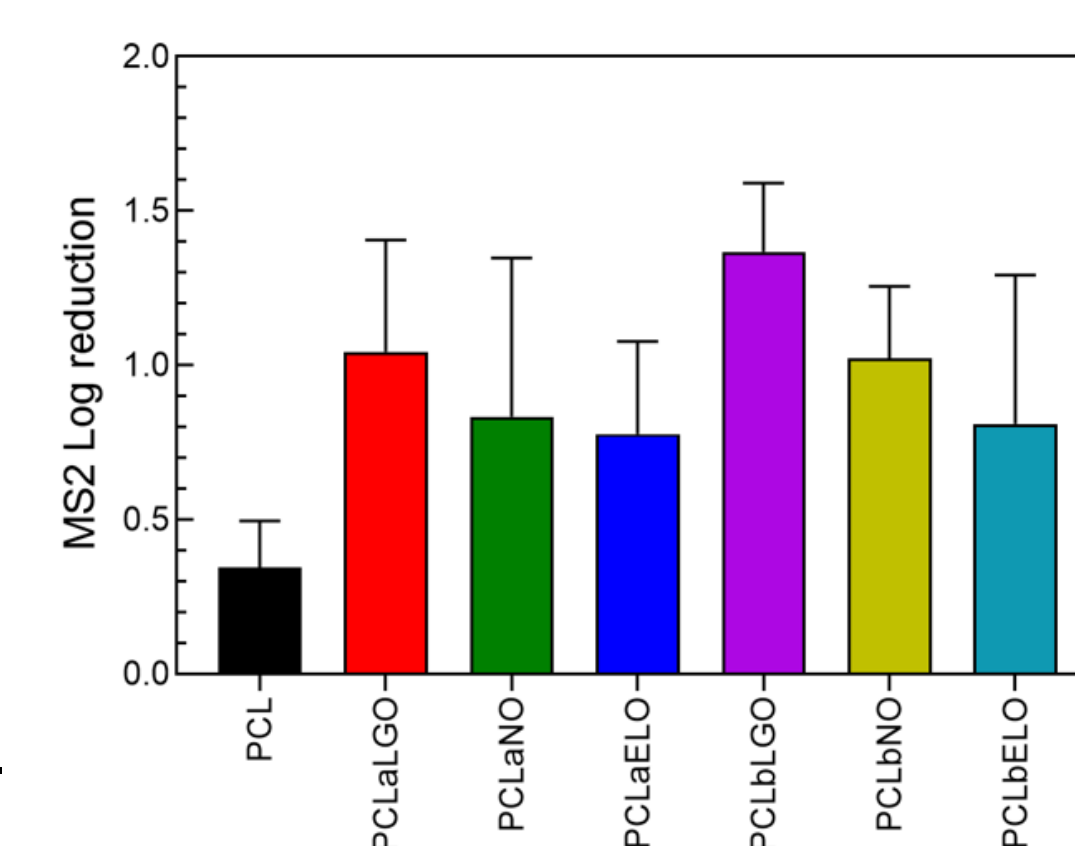


Antimicrobial Effect

Contact Killing Examinations

Microorganism: Bacteriophage MS2 (mimic of SARS-CoV-2)
Initial Concentration (t = 0 h): 3.8x10⁷ PFUs/mL
Incubation Period: 4 h
Temperature: room

MS2 reduction was observed after 4 h of interaction on all EO-loaded mats. **PCL blended with LGO was the most effective from the group in fighting the virus.** PCL on its own was also seen to retain virus within its structure, attesting to its functionality as a potential retaining layer for masks.



Conclusions: Data demonstrated the potential of these EOs-loaded PCL/CA nanofiber mats to work as COVID-19 active barriers for individual protection masks.