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Development of antibacterial wound healing materials using polycaprolactone fibers and ZnO nanoparticles

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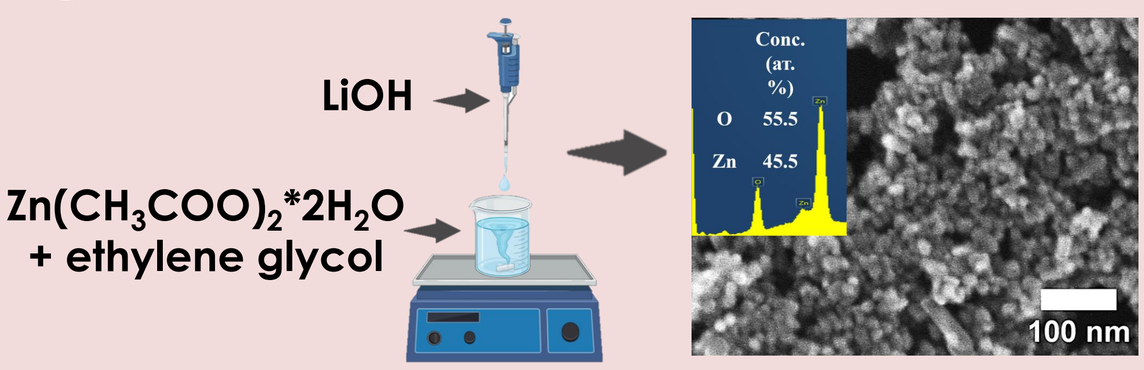
INTRODUCTION

Traditional dressings are inadequate for effective wound healing due to their restricted qualities; however, there is a growing global demand for wound treatment. The occurrence of problems in wound healing is primarily attributed to inflammatory processes triggered by infection with diverse microorganisms. This study involved the development of an antibacterial dressing using electroformed polycaprolactone (PCL) fibers that incorporated zinc oxide nanoparticles (ZnO NPs).

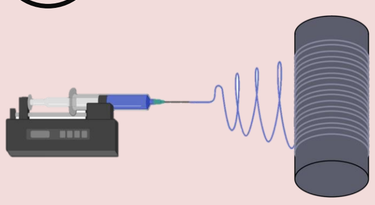
METHODOLOGY FOR DEVELOPING A WOUND HEALING MATERIAL

1 Synthesis of ZnO NPs



$Zn(CH_3COO)_2*H_2O + LiOH \xrightarrow{5\ °C} Zn(OH)_2 \xrightarrow{200\ °C} ZnO$

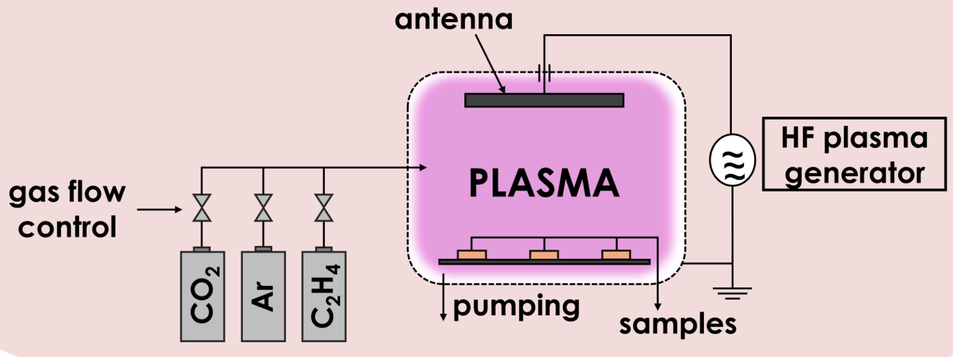
2 Electrospun of PCL-ZnO Nanofibers



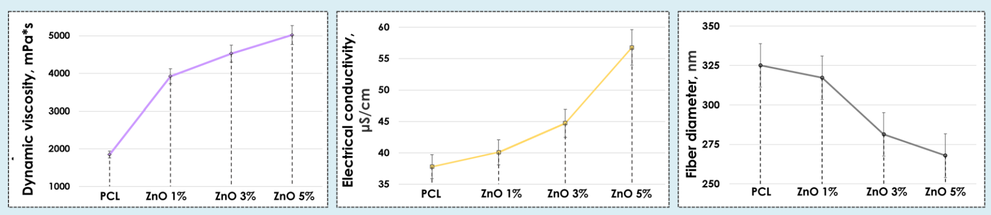
POLIMER SOLUTION:
PCL + acid mixture (glacial acetic acid:formic acid 2:1) + ZnO NPs in concentration of 1%, 3% and 5%

ELECTROSPINNING PARAMETERS: L= 18 cm, U= 45 Kv, Vs= 0,13 µl/s, Vk= 600-650 rpm

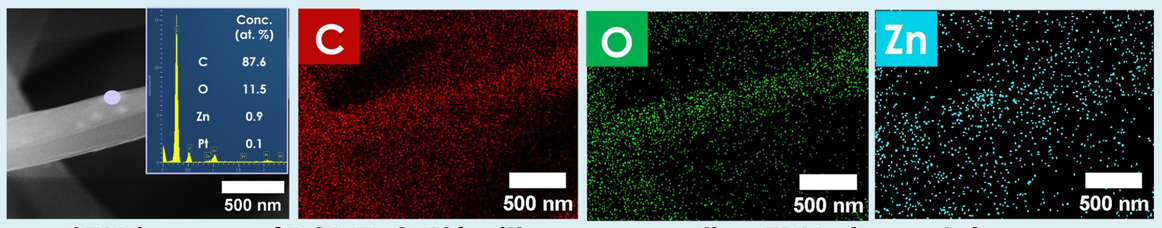
3 COOH Plasma Coating



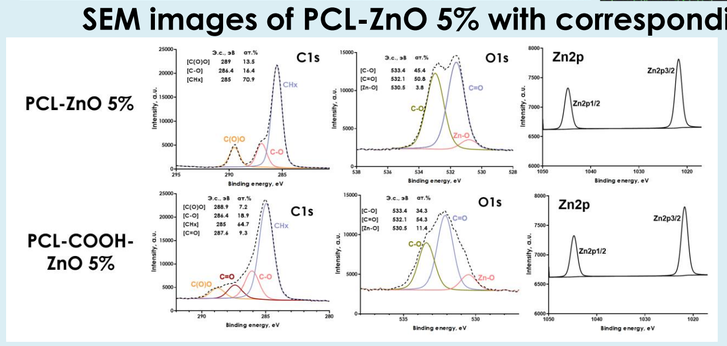
RESULTS



Dynamic viscosity of polymer solutions (A). Electrical conductivity of polymer solutions (B). Diameter of the formed fiber (C).



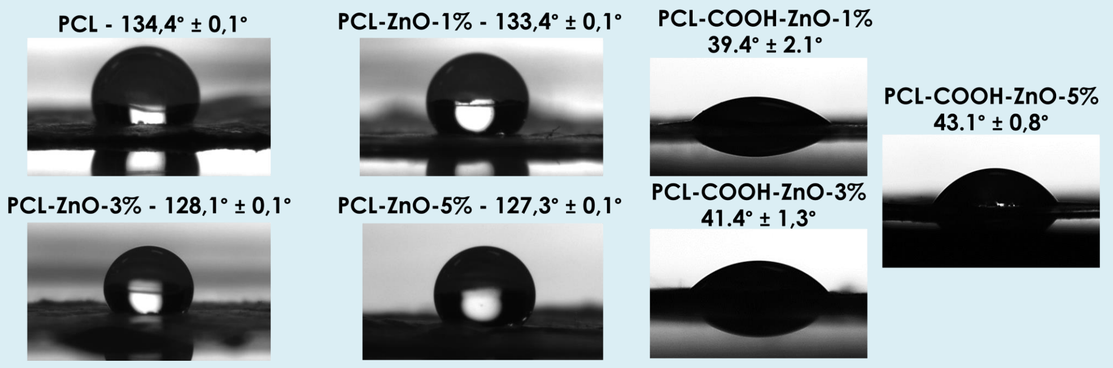
SEM images of PCL-ZnO 5% with corresponding EDX elemental maps.



Sample atomic compositions measured by EDXS

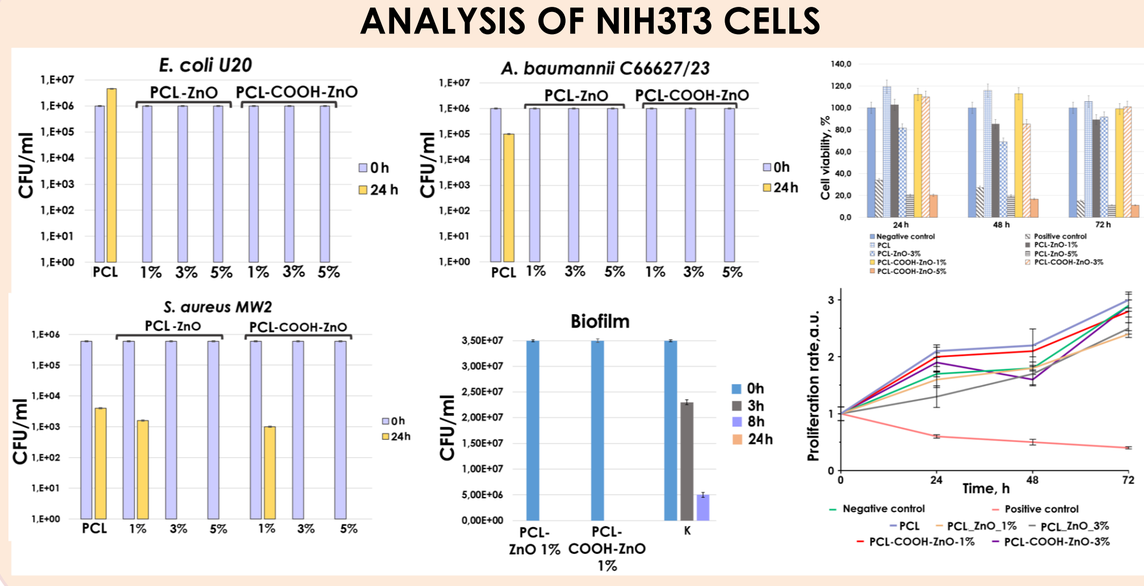
	Concentration, at.%			
	[C]	[O]	[Zn]	[Pt]
PCL-ZnO-1%	88.4	10.4	1.1	0.1
PCL-ZnO-3%	82.1	15.1	2.7	0.1
PCL-ZnO-5%	71.5	24.5	3.9	0.1

XPS C1s, O1s, and Zn2p spectra of samples PCL-ZnO 5% and PCL-COOH-ZnO 5%



Water contact angle of samples PCL, PCL with ZnO NPs and samples after modification

ANTIBACTERIAL ACTIVITY, VIABILLITY AND PROLIFERATION ANALYSIS OF NIH3T3 CELLS



CONCLUSIONS

The inclusion of 3% ZnO NPs is the optimal concentration for wound healing dressing. The material has high antibacterial properties without cytotoxic effect. This study demonstrates the potential of utilizing the composite material in wound healing applications.

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