Fabrication of Antibacterial Thin Films from Essential Oils

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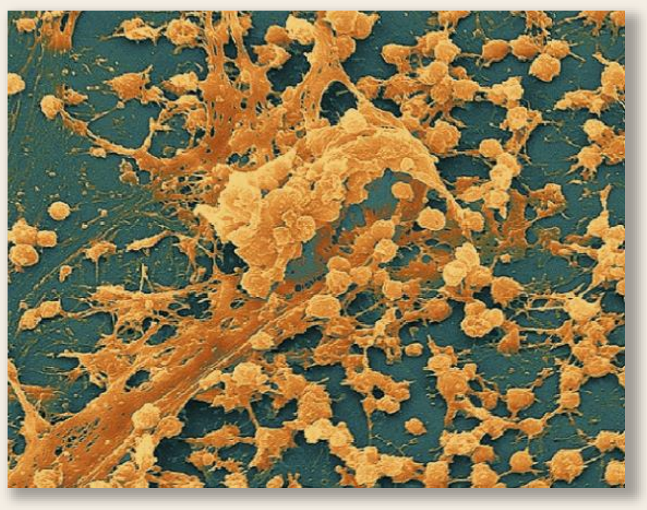
Background and Motivation

S. aureus biofilm on a needle

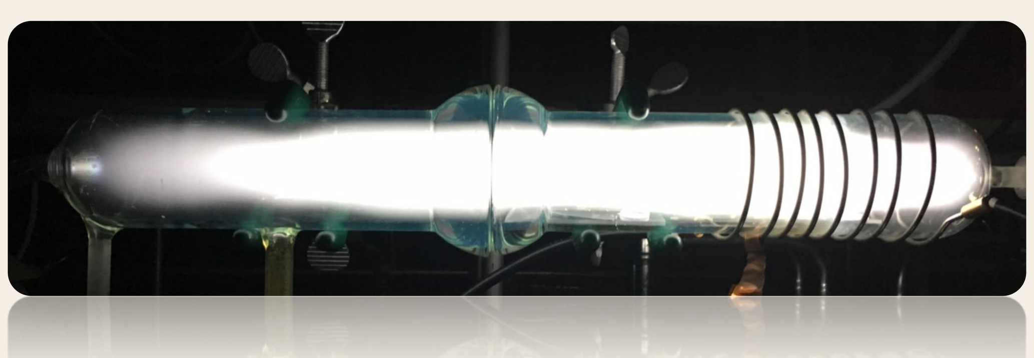


When bacteria attach to a surface, they grow biofilms—thriving colonies strongly resistant to removal efforts. This ultimately leads to biomedical device failure, resulting in *patient infection and material waste*.

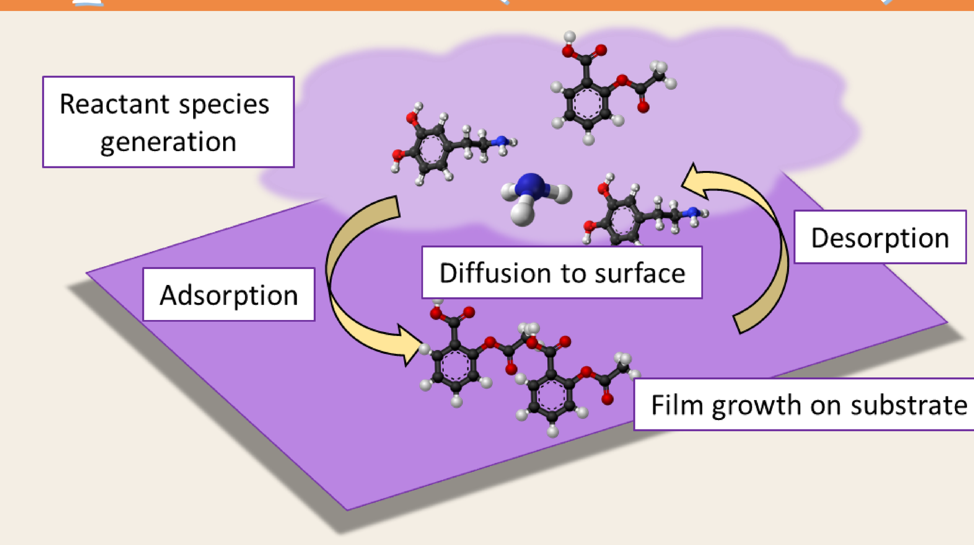
Many essential oils are known for their antibacterial properties

Can antibacterial components of tea tree oil be immobilized as solid coatings on biomedical device surfaces to create advanced materials resistant to bacterial colonization?

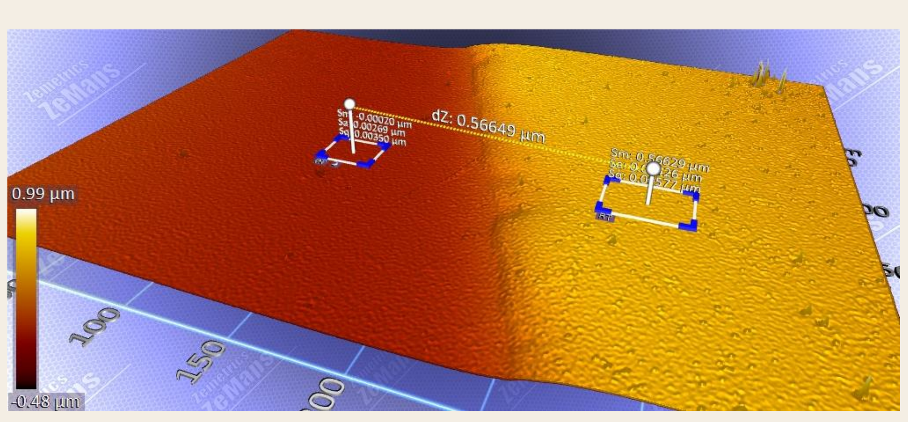
Methods: Plasma Enhanced Chemical Vapor Deposition (PECVD)



In ***PECVD***, the essential oil serves as a liquid monomer and is introduced to the plasma reactor chamber where reactive species are generated. These reactive essential oil species polymerize to *conformally coat the biomaterial* with an adherent pinhole-free thin film.



Analysis of Deposited Films

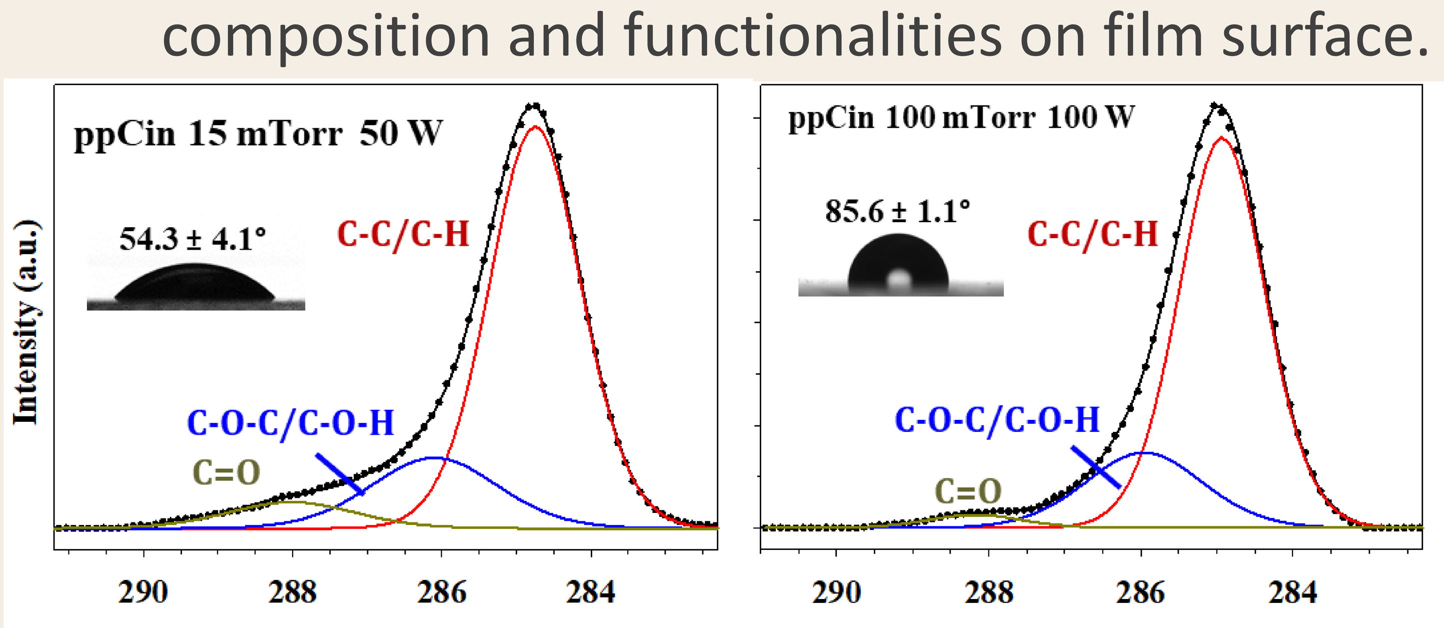


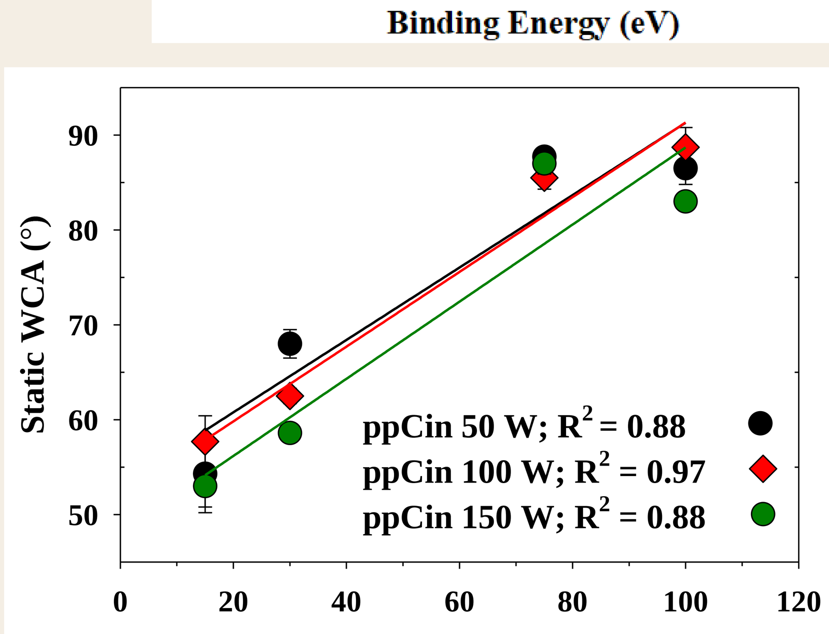
Optical profilometry allows determination of film roughness and deposition rate.

Films are deposited relatively quickly (5-40 nm/min) and are *smooth and conformal*.

Deposition p (mTorr)	P (W)	Deposition rate (nm/min)
15	50	--
	100	4 ± <1
50	50	18 ± 2
	100	19 ± 2
100	50	7 ± 1
	100	35 ± 5

X-ray photoelectron spectroscopy reveals atomic composition and functionalities on film surface.

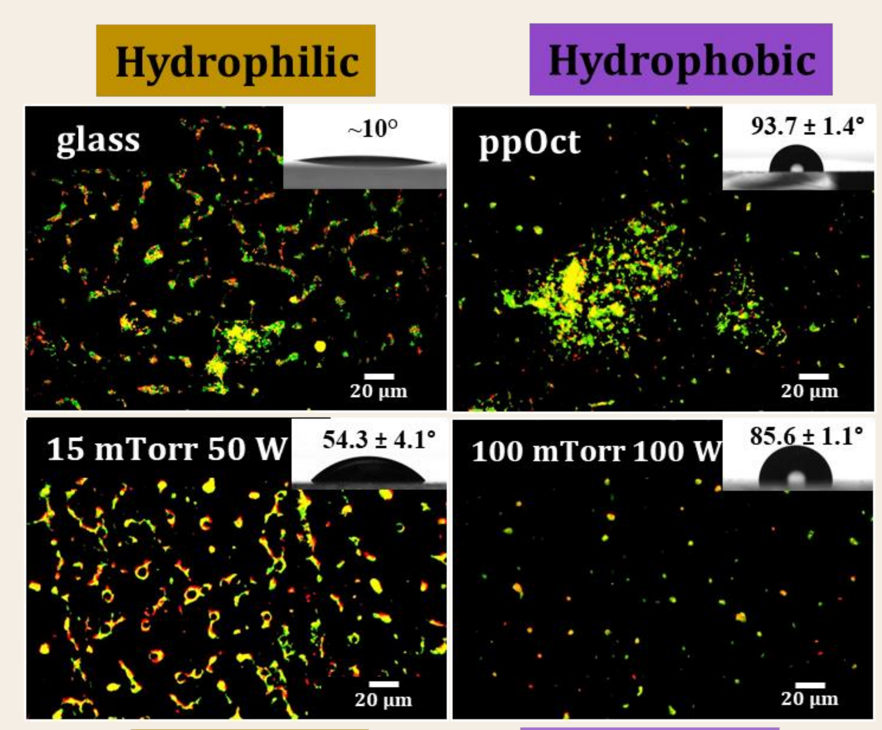


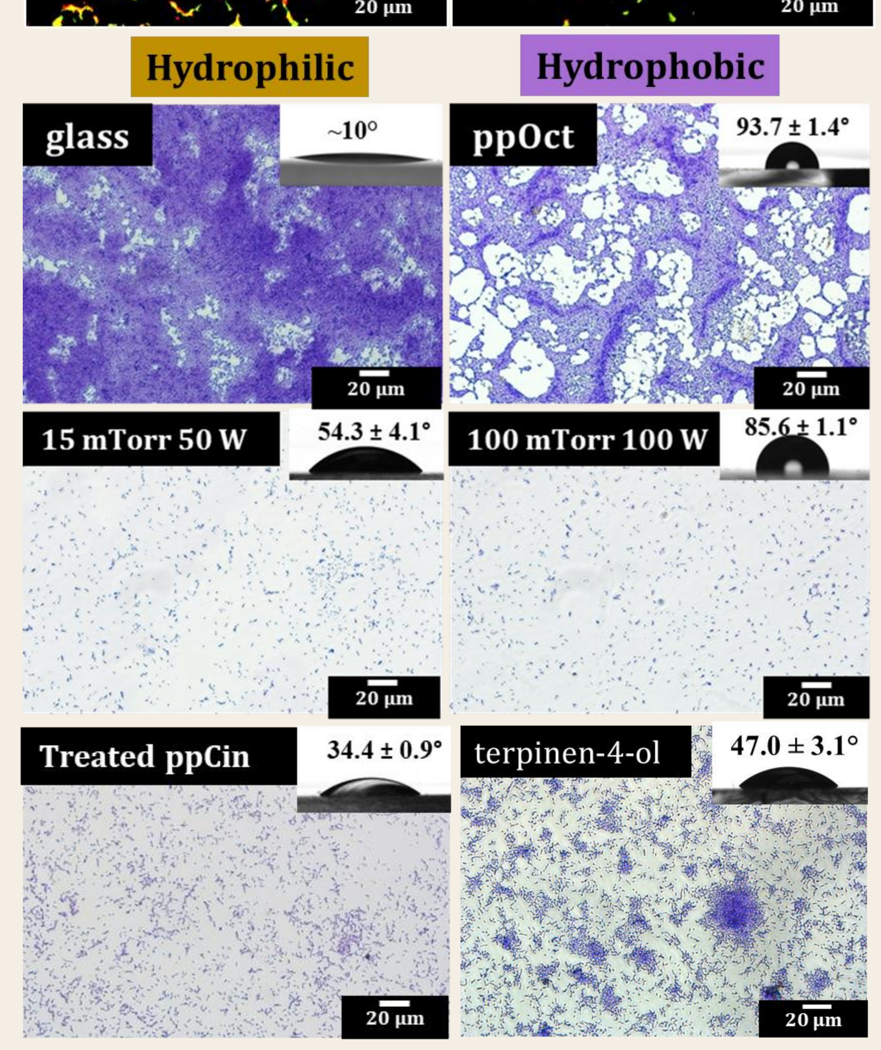


Film	O/C	WCA (°)
15 mTorr 50 W	0.38 ± <0.01	54.3 ± 4.1
15 mTorr 100 W	0.37 ± <0.01	57.7 ± 2.7
100 mTorr 100 W	0.23 ± 0.03	85.6 ± 1.1

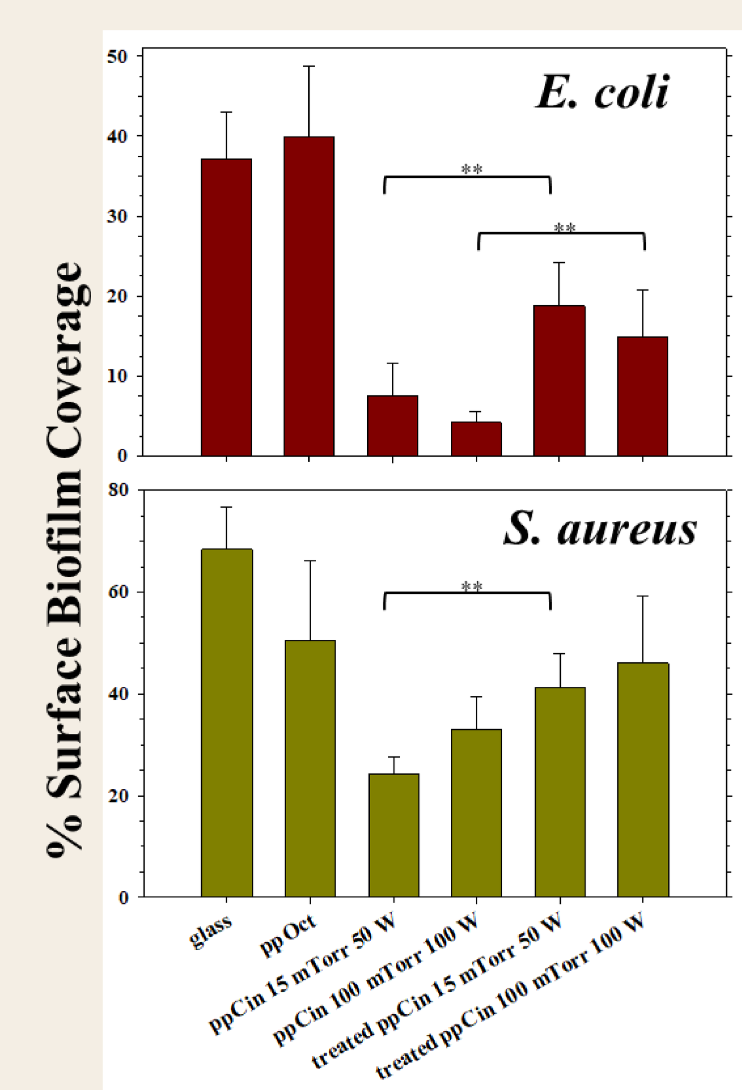
Water Contact Angle (WCA) goniometry reveals film wettability is customizable.

Biological Performance Testing





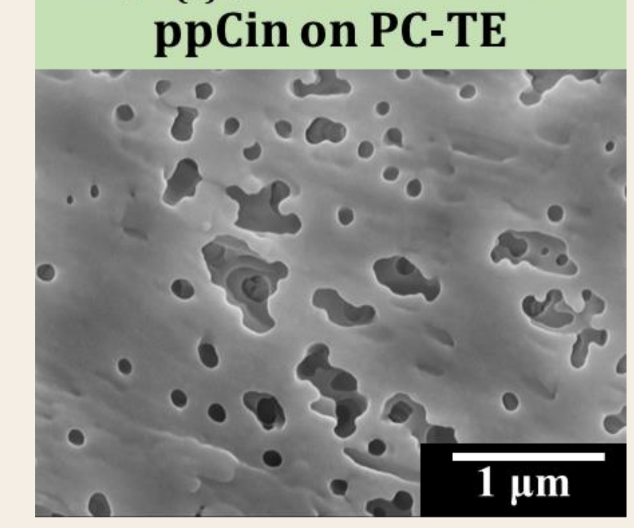
When deposited on filtration membranes, coatings resist protein adsorption and maintain performance of membranes, *making them ideal for blood dialysis and water treatment*.



Exposing films to *E. coli* and *S. aureus* for 1-5 days reveals films resist biofilm growth, even after $H_2O_{(v)}$ plasma treatment

Antibacterial effect is not only a function of film wettability.

$H_2O_{(v)}$ plasma treated ppCin on PC-TE



Future Directions

- Spectroscopic study of plasma species
- Further biological optimization
- Blood coagulation dynamics

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