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Nanostructured coatings with antimicrobial activity to prevent pathogen transmission on high touch hospital settings

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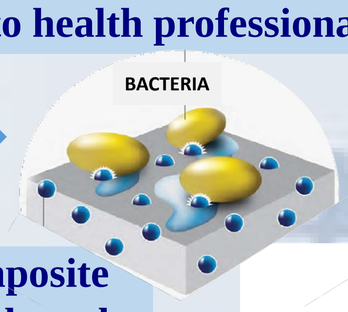
Introduction

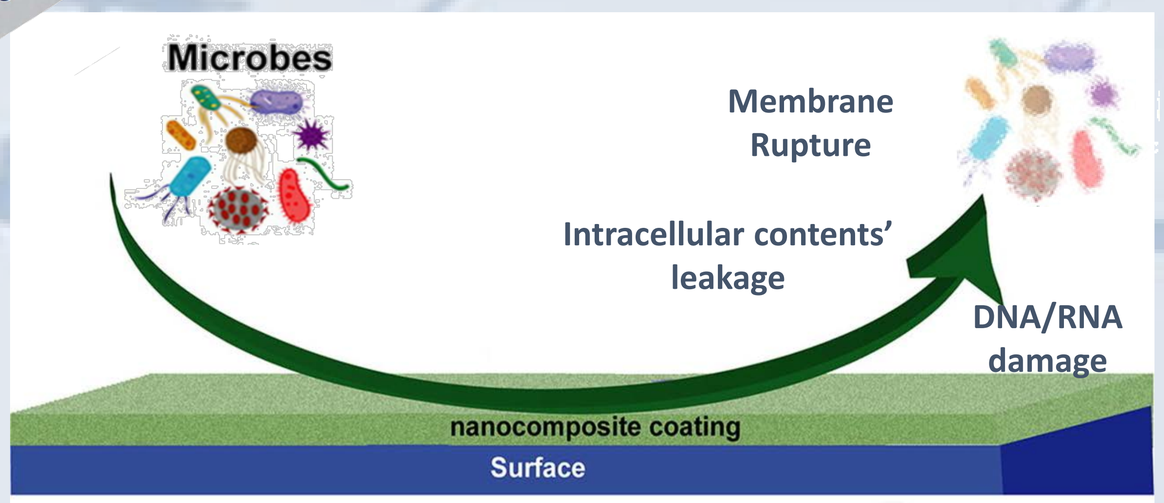
Prevention of Health Care Associated Infections (HCAI) represents a major worldwide challenge for both scientific research and industrial sectors. Due to the current pandemic situation, it has become a fundamental demanding issue.
Pathogenic microorganisms may persist on different surfaces for long period, contaminating items, equipment and "common" area in hospital settings and rooms leading to serious infections and epidemic outbreaks. To mitigate public health risk, the main approaches include both collective protectives measures, such as cleaning and disinfection of High Touch Surfaces, and Personal Protection Equipment usage. These protective measures may have limited efficacy to inhibit bacterial growth and they even cause damage to human health. For instance, the massive and prolonged use of disinfectants poses a chemical risk to health professionals as well as causing environmental damage.

Microbial bio-burden on health care surface lead to acquisition of Healthcare Associated Infection (HAIs)



Residual Pathogens on a contaminated surface may be transferred to susceptible patients either via the care workers' hands or portable medical equipment

- **Self-disinfecting surfaces covered by nanocomposite antimicrobial coatings (AMC) to kill or to inhibit growth and permanency of pathogens (i.e. virus, bacteria, fungi) from high-touch surfaces preventing microbial bio-burden accumulation.**
- **AMC in vitro antibacterial (*S. aureus* ATCC 6538P, *E. coli* ATCC 8739) activity evaluation by using both the ISO 22196:2011 and a new method capable to assess the reduction in the number of bacterial colonies under hospital environmental real conditions**



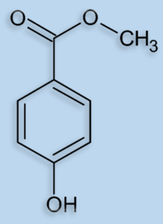
Materials and Methods

POLYMERIC MATRICES

Chitosan HAVOH PCL

ACTIVE NANOPARTICLES

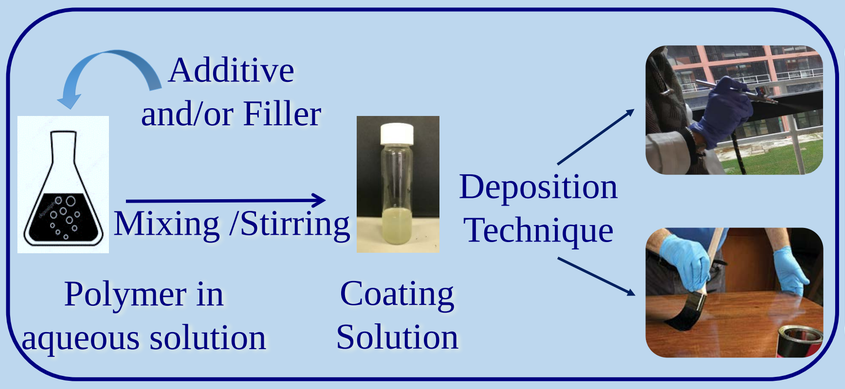
ORGANIC AM



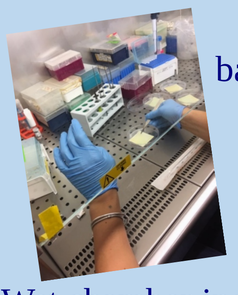
INORGANIC CARRIER

(i.e. Hydrotalcite)

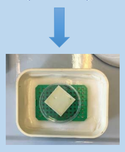
- ✓ Active properties' preservation
- ✓ Active substances' modulate release



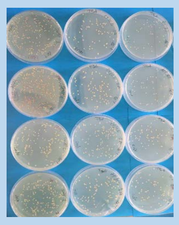
ISO 22196:2011



PE film on the bacterial suspension (24h)



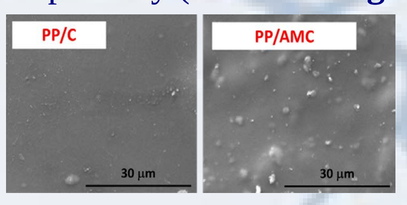
Counting colonies 24 h

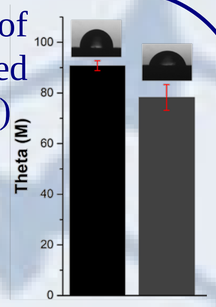


Wet chamber incubation (RH >90%) at 36±1°C

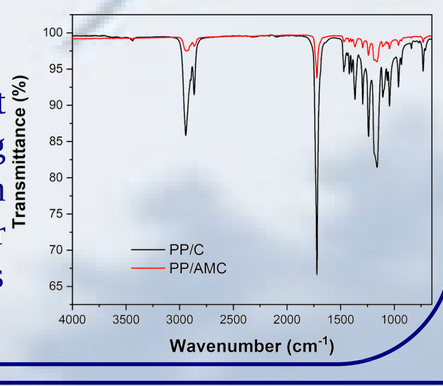
Characterization and Results

Achieved good dispersion of AM filler (**SEM**) and enhanced hydrophilicity (**Contact Angle**)





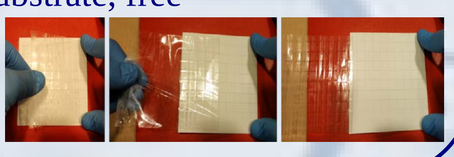
FTIR reveal that the AM loading induce a reduction of the polymer characteristic peaks



Water Resistance

The coated substrate is put into petri dishes containing water and removed at specific times, after 5 hours the image shows that the coating is water resistant

Adhesion measurements by Type Test (ASTM D3359 – Method A): adhesion of coating films to substrates by applying and removing pressure-sensitive tape over cuts made in the film: 10 x 10 cm² area substrate, free of imperfections, cut through the film up to the support, creating a lattice at right angles on the surface



Biocompatibility *in vitro* test of AMC

up to 7 days of cell culture expressed as reduction of Alamar blue normalized percentage to plate control. °p< 0,001; #p< 0,0001 vs HDF cells

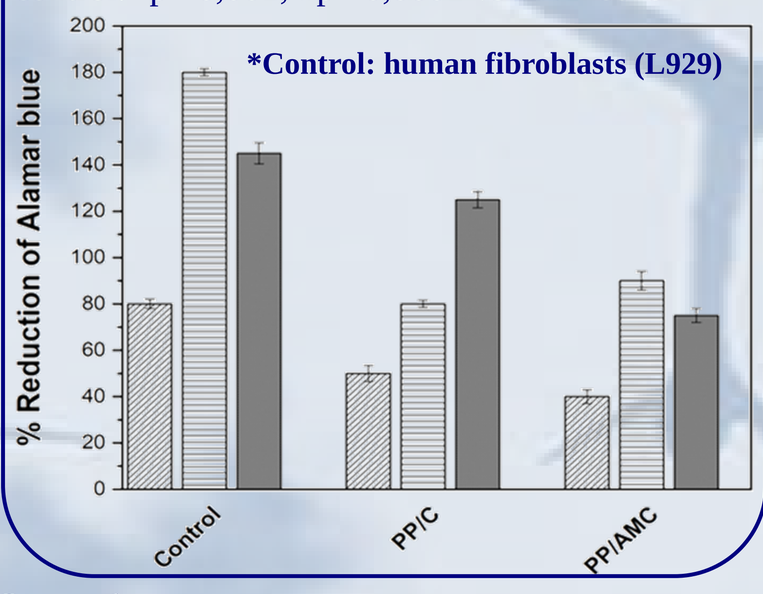
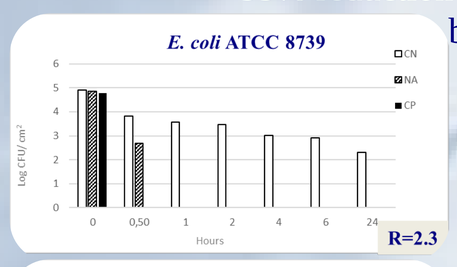
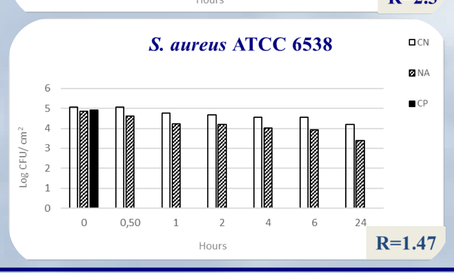


Table 1. Comparison between the results obtained with the new method and those by ISO standard method

	*R value**	
	ISO 22196:2011	NEW METHOD
E. coli ATCC 8739	5.78	2.30
S. aureus ATCC 6538	3.77	1.47

R= 2.30
99% reduction in the number of bacterial colonies





CN= PP/C

NA= PP/AMC

CP= Copper

*R value = Reduction in the number of bacterial colonies expressed as Log CFU/cm²

Conclusion

Our results highlight that the developed AMC shows bactericidal activity against both tested strains, particularly towards *E.coli* (reduction value = 5.78 Log UFC/cm²) and that the new method for *in vitro* tests used in this study provides information on the real antibacterial efficacy of new materials under temperature and humidity conditions comparable to those in the target environments.

Acknowledgment

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