Novel Antimicrobial Nylon with Embedded Zinc Ions for One Health Applications

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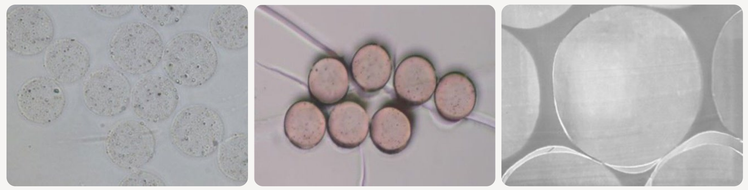
Introduction

The World Health Organization (WHO) has called for innovative solutions to the threat of antimicrobial resistance caused by multi-drug resistant (MDR) superbugs. Zinc has the potential to address this urgent requirement due to its natural ability to eradicate microbes. A novel polymer based on high performance nylon that incorporates and maintains zinc in its ionic form was investigated against WHO priority pathogens. Zinc ions are embedded in the polymer matrix during production of nylon and are activated upon moisture absorption from the atmosphere. This long-lasting, skin-friendly technology has the potential to permanently protect wound care products from bacteria, therefore improving patient outcomes. Zinc allows for bacteria protection with reduced risk for developing resistance while being a skin friendly solution that can be incorporated with no additional operations at manufacturer.

Technology - Nylon with Embedded Zinc Ions

- Zinc ions are embedded in the polymer matrix during the polymerization process and are activated upon moisture absorption from the atmosphere
- The active ingredient is distributed throughout at the molecular level in the polymer matrix without forming any particulates
- This process is possible due to the chemical compatibility between Zinc ions and monomers used to produce Nylon 6,6.

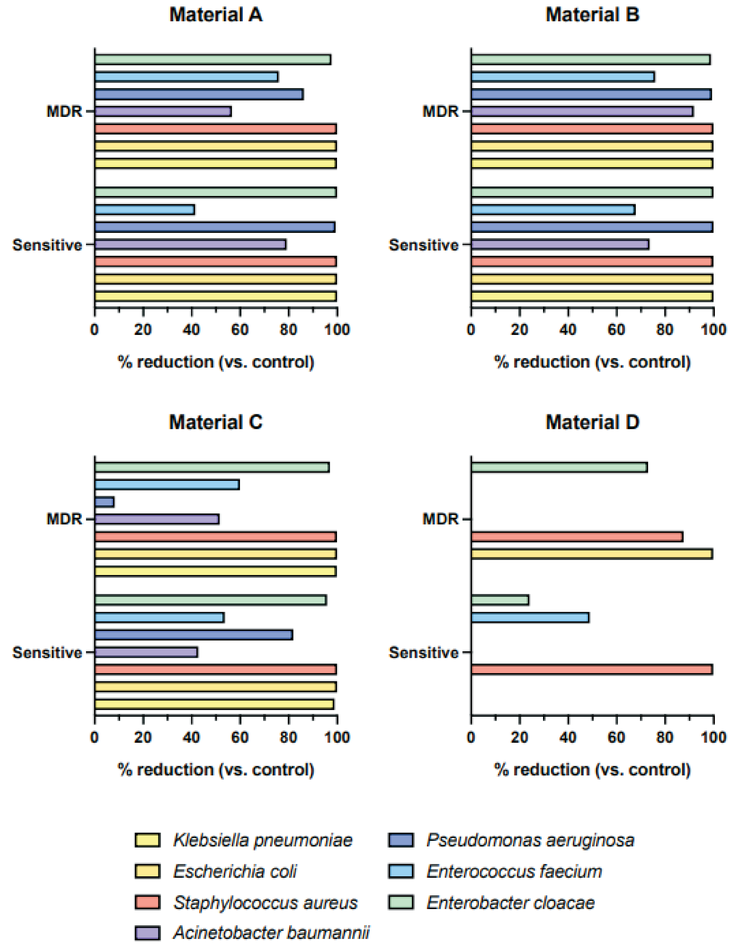


Compounded **Silver Coated** **Zn Polymerized**

Methods

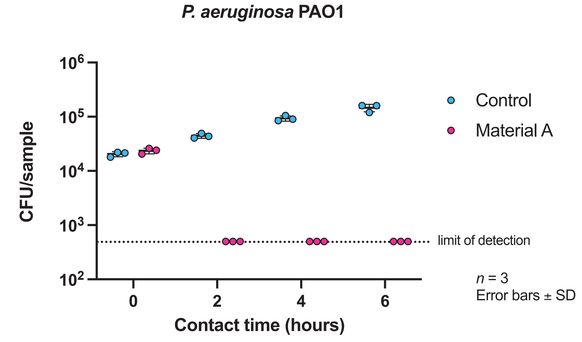
A novel material was created by embedding activated Zn into nylon, creating a homogeneous substrate that then was converted into four distinct non-woven and textile forms. These were evaluated for antimicrobial efficacy against significant pathogens using industry standard ISO20743 as a testing framework. Antibacterial efficacy was tested after 24 hours against both sensitive and multidrug resistant (MDR) isolates of seven bacterial species compared to the control material. The contact time for efficient antibacterial activity, or time to kill, was also determined against P. aeruginosa. Sustained antibacterial efficacy against all seven species was determined by comparing the log reduction of the samples before and after 50 wash/dry cycles.

Bio-efficacy against priority pathogens

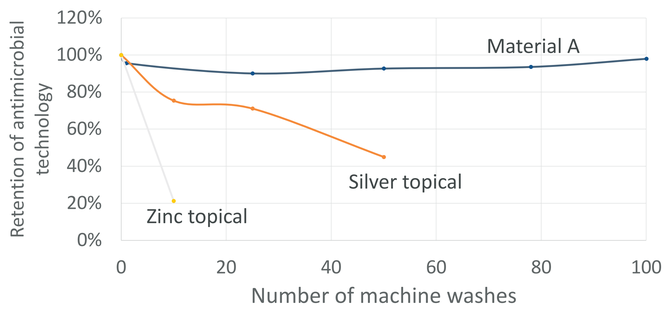


- The antibacterial efficacy varied depending on the forms used and bacterial species. Knitted fabric (Material A) and spunbond (Material B), which can easily be incorporated in wound dressings, had the most antibacterial efficacy.
- Material B with Zinc embedded nylon were found to be non-cytotoxic (Nelson Lab, CTX110).
- The reduction in viable bacteria was greater than 99% for five of the seven species.
- This technology demonstrated high effectiveness against most of the strains tested against both sensitive and multidrug resistant isolates.

Time-to-Kill analysis



Time-to-kill analyses reveal that these materials exert antibacterial activity shortly after contact, with potent activity observed within 2 hours.



- Zinc retention analyses showed that Material A retains embedded zinc ions after multiple machine wash cycles unlike topical coated products
- Antibacterial efficacy was similar after washing for most strains tested, with exceptions observed.

Conclusion

- This work shows that zinc ion embedded nylon polymers have antibacterial efficacy against WHO priority pathogens, a desired property for designing wound and skin care products.
- Potent antibacterial activity occurs within two hours of contact time, while proven to be non-cytotoxic.
- After 50+ washes, circular knit with this technology still demonstrates antibacterial efficacy, therefore has the potential applications in the reusable products.