2C2T Centre for Textile Science and Technology

Universidade do Minho
Escola de Engenharia

P2.007

Frontiers in polymer science
29 May - 1 June 2023 | Gothenburg, Sweden
materialstoday
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The assessment of bacterial nanocellulose functionalized with metal nanoparticles

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INTRODUCTION

Biocompatibility is one of the mandatory requirements of indwelling medical devices to avoid foreign body reactions and consequential surgical removal.

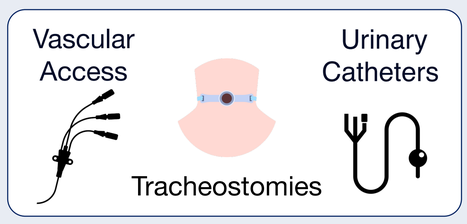
These types of devices must be developed with advanced materials, preferably bio-based and bio-inspired. Bacterial nanocellulose (BNC) is a biopolymer that encompasses an impressive set of key features, including superior biocompatibility, easy modification, and nonbiodegradability.

Considering the risk of infection after surgery and the lack of antimicrobial properties of BNC, this biopolymer was functionalised with highly stable materials with extended periods of activity, such as commercial (silver/zinc) and synthesised (copper/copper oxide) nanoparticles (NPs).

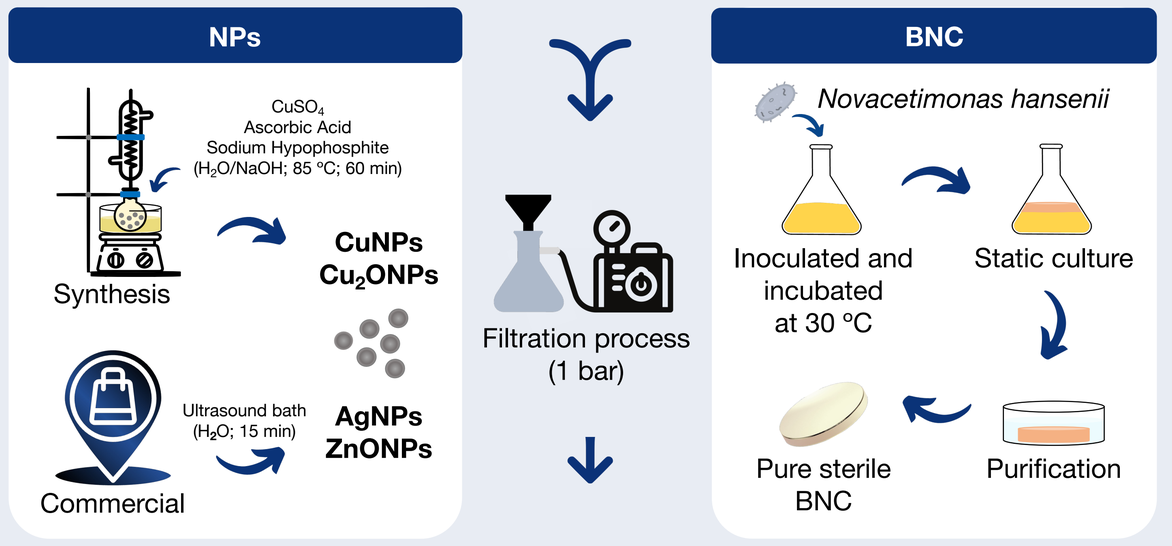
OBJECTIVE

Development of a durable, biocompatible, and antimicrobial composite based on BNC functionalised with metal NPs.

These are excellent alternatives to synthetic products applied in indwelling medical devices.



METHODOLOGY



RESULTS AND DISCUSSION

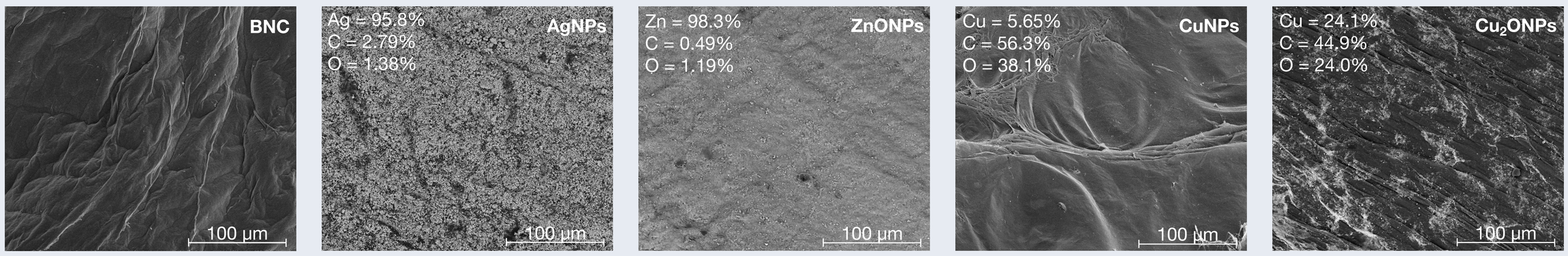


Figure 1. SEM images with 1000x of magnification (surface) and EDS of the BNC composites (values inserted in the figures).

- → Commercial NPs evenly distributed on the surface of the BNC;
- → Higher concentration of commercial NPs in comparison to synthesised NPs;
- → BNC+CuNPs composite shows a near absence of CuNPs on its surface, which may indicate a higher presence inside the BNC membrane.

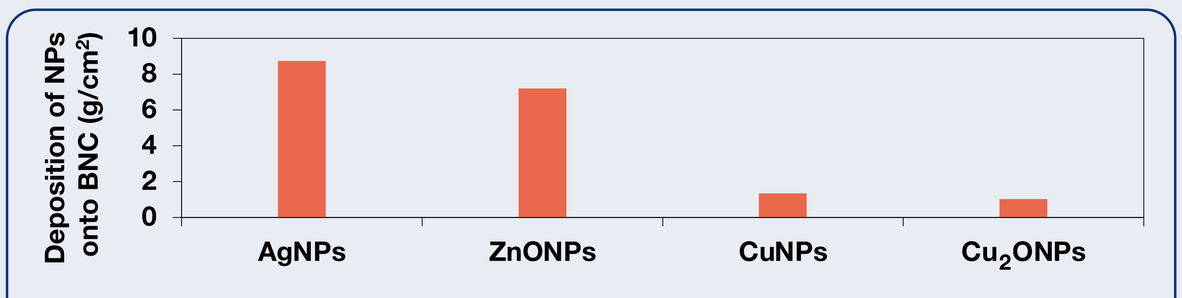


Figure 2. Deposition of NPs onto BNC, according to AAS.

- → Synthesised NPs present good to excellent process efficiency (80.2% for Cu_2ONPs; 99.8% for CuNPs), however, due to initial low amount, their deposition per area is low;
- → Interesting deposition yield and process efficiency of commercial NPs (99.6% for AgNPs and ZnONPs).

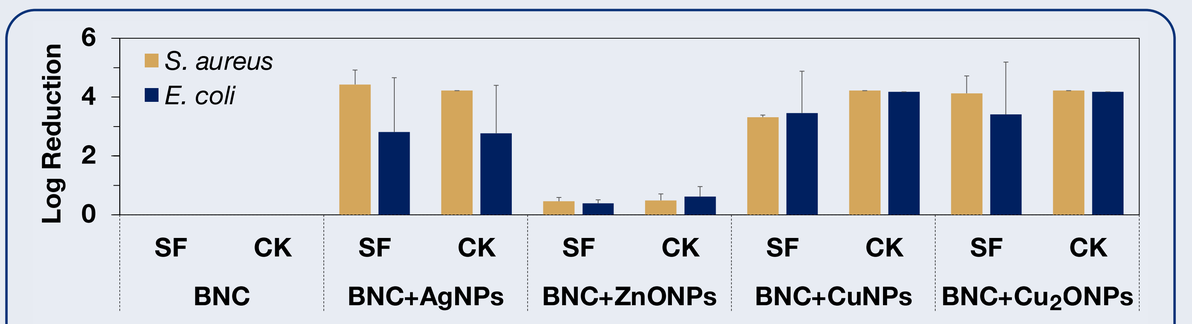


Figure 3. Antimicrobial activity of the composites developed, according to standards AATCC TM 100 (Contact Killing – CK) and ASTM E2149-01 (Shake Flask – SF).

- → Increased antimicrobial activity detected by contact (NPs onto the BNC surface);
- → ZnO did not exhibit antimicrobial activity without UV activation;
- → CuNPs and Cu_2ONPs exhibited similar or even higher antimicrobial activity than AgNPs and can be classified as moderate disinfectant (4 log reduction).

CONCLUSIONS

- ✓ CuNPs and Cu_2ONPS, even with a lower deposition efficiency, have disinfectant properties similar to AgNPs;
- ✓ Ensure, as a future work, that the composites developed did not affect the biocompatibility and intrinsic properties of the BNC;
- ✓ CuNPs and Cu_2ONPs comprise a potential to be considerably less cytotoxic than AgNPs (lower concentration and superior biocompatibility of these NPs);
- ✓ These composites present excellent properties for indwelling medical devices, being an excellent substitute for synthetic materials.

ACKNOWLEDGEMENTS

This research was funded by FEDER funds through the Operational Competitiveness Program–COMPETE, under the project POCI-01-0247-FEDER-068924 and by National Funds through Fundação para a Ciência e Tecnologia (FCT), under the project UID/CTM/00264/2020. Cátia Alves, Liliana Melro, Behnaz Mehravani, and Ana Isabel Ribeiro acknowledge FCT, MCTES, FSE, and UE PhD grants 2022.10454.BD, 2020.04919.BD, 2022.13094.BD, and SFRH/BD/137668/2018.