coPOLY - Polymers reinforced with copper to promote an antimicrobial effect

J.F.A. Valente, C. Santos, H. Marques, A. Mateus, N. Alves

Centre for Rapid and Sustainable Product Development
Polytechnic of Leiria

ICDDMAP2021

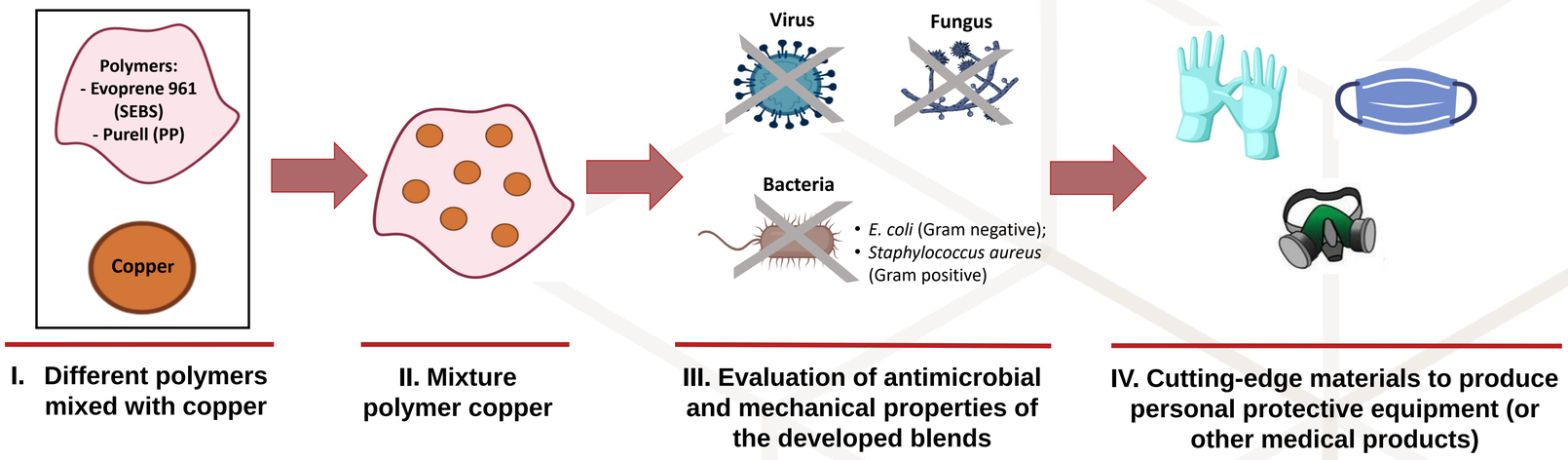
Public Exhibition 20 - 22 May

International Conference on Direct Digital Manufacturing And Polymers

SUMMARY

The current pandemic situation leads us to adapt to this new reality and to search for alternatives regarding the materials that we use daily. Among the most studied materials presenting antimicrobial characteristics are the ones combined with copper. In this regard, it was produced and optimized different polymeric/copper combinations with antimicrobial properties that can be applied for different purposes (gloves, visors, masks, disposable medical supplies, among others). Overall, it will be possible to produce materials able to really protect the users since instead of been used only as a physical barrier against pathogens, they will have the ability to eliminate them when in contact.

Graphical abstract



INTRODUCTION

Polymers are often selected to provide a physical barrier against pathogens however, they can also lead to the spread and contamination of the population which is considered a serious problem. Mixing these materials with copper (an antimicrobial material) have been shown to promoting viral inactivation.

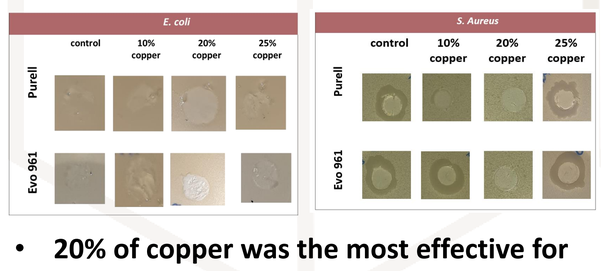
The inactivation of the H1N1 influenza virus [1] and human immunodeficiency virus (HIV) [2] by copper metal and divalent copper ions (Cu II) has been reported. The antiviral activity of copper nanoparticles against the hepatitis C virus have been demonstrated [3]. Human coronavirus tests have been carried out, showing rapid inactivation in the presence of a variety of copper alloys (within a few minutes in some cases)[4].

It has been shown that the Cu (I) and Cu (II) ions are responsible for viral inactivation, which improves by the generation of reactive oxygen species on the surfaces of the alloys, irreversibly affecting the morphology of the virus, including the disintegration of its envelope and the dispersion of the surface peaks [5].

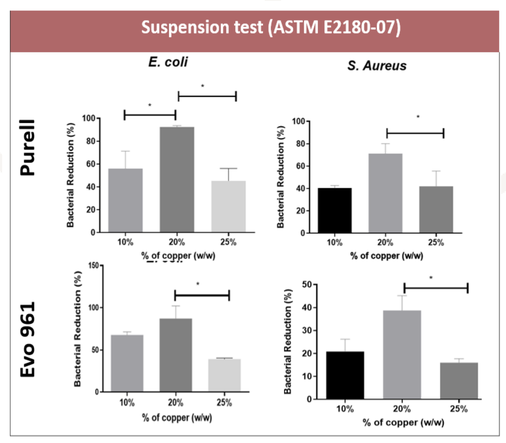
In this research work we present several combinations of polymer/copper as well as their mechanical, physical and antibacterial characterization.

RESULTS AND DISCUSSION

Antimicrobial Evaluation

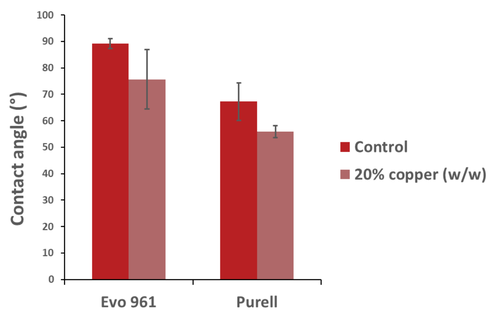


- **20% of copper was the most effective for both polymers regardless the bacteria studied;**
- **The best bacterial reduction was performed for *E. coli*.**



Physical and mechanical characterization

Contact angle



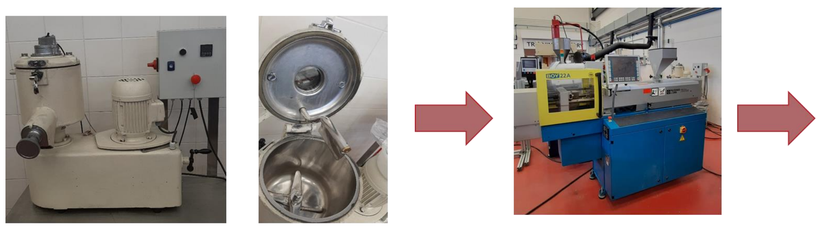
Surfaces with copper are less hydrophobic than the blanks. This could indicate that the antibacterial effect is related with the copper effect.

Mechanical characterization

	Purell		Evo 961	
	Control	20 % Copper (w/w)	Control	20% Copper (w/w)
Maximum tension (MPa)	27.1±4.1	19.3±1.2	3.9±0.2	3.2±0.34
Young modulus (MPa)	1207±137	844±128	5.5±0.75	5.6±0.2

A (slight) loss of properties was observed in case of polymer/copper blends however, this loss was not sufficient to compromise the good functioning of the polymer

METHODOLOGY



CONCLUSIONS

- **With coPOLY was possible to develop several combinations polymer/copper with antibacterial effect;**
- **20% of copper was the amount needed to achieve the highest antimicrobial effect for all the polymer studied;**
- **Copper appears to influence more the bacterial growth than the surface hydrophobicity;**
- **There were some loss on the mechanical properties of the copper/polymer blends however, this loss is not significant to compromise the good functioning of the polymer.**

REFERENCES

[1] Y. Fujimori, T. Sato, T. Hayata, T. Nagao, M. Nakayama, T. Nakayama, R. Sugamata, K.J.A.E.M. Suzuki, Novel antiviral characteristics of nanosized copper (I) iodide particles showing inactivation activity against 2009 pandemic H1N1 influenza virus, 78(4) (2012) 951-955.
[2] G. Borkow, H.H. Lara, C.Y. Covington, A. Nyamathi, J.J.A.a. Gabbay, chemotherapy, Deactivation of human immunodeficiency virus type 1 in medium by copper oxide-containing filters, 52(2) (2008) 518-525.
[3] X. Hang, H. Peng, H. Song, Z. Qi, X. Miao, W.J.J.o.v.m. Xu, Antiviral activity of cuprous oxide nanoparticles against hepatitis C virus in vitro, 222 (2015) 150-157.
[4] S.L. Warnes, Z.R. Little, C.W.J.M. Keevil, Human coronavirus 229E remains infectious on common touch surface materials, 6(6) (2015) e01697-15.
[5] M. Vincent, R.E. Duval, P. Hartemann, M.J.J.o.a.m. Engels-Deutsch, Contact killing and antimicrobial properties of copper, 124(5) (2018) 1032-1046.

ACKNOWLEDGMENTS

This work is supported by the **Fundação para a Ciência e a Tecnologia (FCT)** and **Centro2020** through the following Projects: UIDB/04044/2020, UIDP/04044/2020, PAMI - ROTEIRO/0328/2013 (Nº 022158), MATIS (CENTRO-01-0145-FEDER-000014) and Centro-01-02B7-FEDER-069244

CONTACTS

Joana.valente@ipleiria.pt

FCT Fundação para a Ciência e a Tecnologia · CENTRO 2020 · COMPETE 2020 · PORTUGAL 2020 · UNIÃO EUROPEIA Fundo Europeu de Desenvolvimento Regional · POLITÉCNICO DE LEIRIA · CDRSP CENTRE FOR RAPID AND SUSTAINABLE PRODUCT DEVELOPMENT · LCRPERFIS TRANSFORMAÇÃO DE POLÍMEROS · DREAMPLAS Lda.