ANTIMICROBIAL PROPERTIES OF POLYMERS USED IN 3D PRINTING METHODS

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Introduction

The possibilities of 3D printers are more and more often used for the production of medical devices, personalized prostheses as well as materials and elements of devices that support a sick person. The condition that allows the use of 3D printing is its non-toxicity in relation to the human body, bacteriostaticity, insensitivity to environmental factors and resistance to abrasion. Commonly used materials used in this printing technique are PLA (polylactide - poly (lactic acid) and ABS (poly acrylonitrile-co-butadiene-co-styrene). ABS and PLA belong to thermoplastic materials that are easy to machine, unfortunately May too low strength parameters, hence chemical modification is necessary PLA belongs to the group of aliphatic polyesters Its advantages are: biodegradability, odorlessness, high resistance to UV radiation and extraction from natural resources, that is environmentally friendly ABS has good plasticity And solubility in organic compounds, thanks to which you can easily combine printed parts [1,2].

The present study evaluated the bacteriostaticity of the polymers mentioned above for 3D printing, PLA (polylactide) and ABS (acrylonitrile butadiene styrene terpolymer) and their microstructural properties using XRD.

Materials and Methods

Four species of microorganisms from the American Collection of Pure Cultures were tested: Actinomyces viscosus ATCC 15987 + D1291, Escherichia coli NCTC 12241 / ATCC 25922, Staphylococcus aureus NCTC 12981 / ATCC® 25923, Streptococcus sanguis ATCC10556. In the study, polymers used for 3D printer - PLA (yellow discs) and ABS (red discs) were tested.

The antimicrobial activity of the polymers was evaluated by the direct method based on the criteria contained in the SN 195920 standard. The bacterial culture was performed on TSA medium.

The susceptibility of the surfaces of the coatings to microbial adhesion was carried out in accordance with the procedures included in the standard: ISO 22196: 2011 (Plastics: Measurement of antimicrobial activity of plastics and other non-porous surfaces)

with modifications regarding the assessment of microbial viability.

The microstructure of the test specimens was investigated by Empyrean's XRD-Expert Multiprocesore Diffractometer.

Results and Discussion

Bacteriostatic assessment of coatings showed in each case tested bacteria their inhibition (FIG. 1).

Actinomyces viscosus *Escherichia coli* *Staphylococcus aureus* *Streptococcus salivarius*

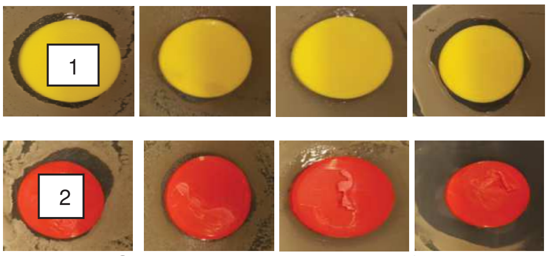

FIG. 1. Antimicrobial activity of polymers.

In the assessment of bacterial adhesion to polymers (FIG. 2), it was observed that the least live and dead bacteria were on the PLA polymer samples in the case of *Streptococcus sanguis*. Actinomyces viscosus bacteria on the ABS polymer were found the most. Assessment of adhesion to bacterial polymers showed that the number of bacteria on the ABS material is definitely higher.

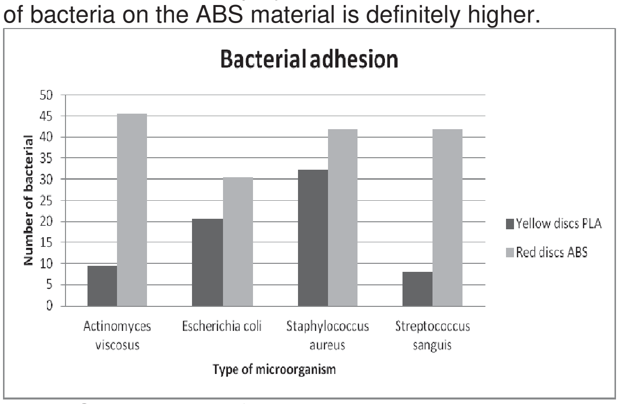

FIG. 2. Number of cells that adhere to polymers.

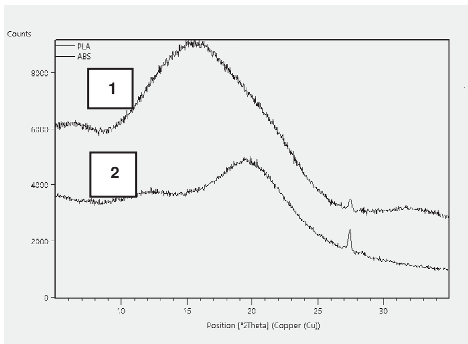

FIG. 3. XRD diffraction of 1-PLA, 2-ABS.
CoKα1 (λ = 0,17902 nm)

Microstructural studies (XRD) of polymeric samples (FIG. 3) have shown that they are characterized by crystalline - amorphous submicroscopic structure, confirming their ability to develop crystalline areas.

On the diffractogram of the ABS polymer sample, visible diffraction lines from planes (002) are visible. In the case of PLA polymer samples, a diffraction line from planes (200) [3] is visible.

Conclusions

The tested materials showed static action on bacteria, hence their use in places with a special threat of microbial contamination can be considered.

References

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[3] Y. Zhou, L.Lei, B.Yang, J.Li, J.Ren; Polymer Testing Volume 68, July 2018, Pages 34-38.