SURFACE MODIFICATION OF POLYLACTIDE (PLA) WITH SILVER

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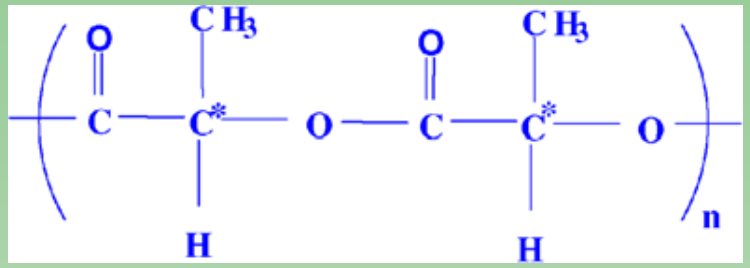
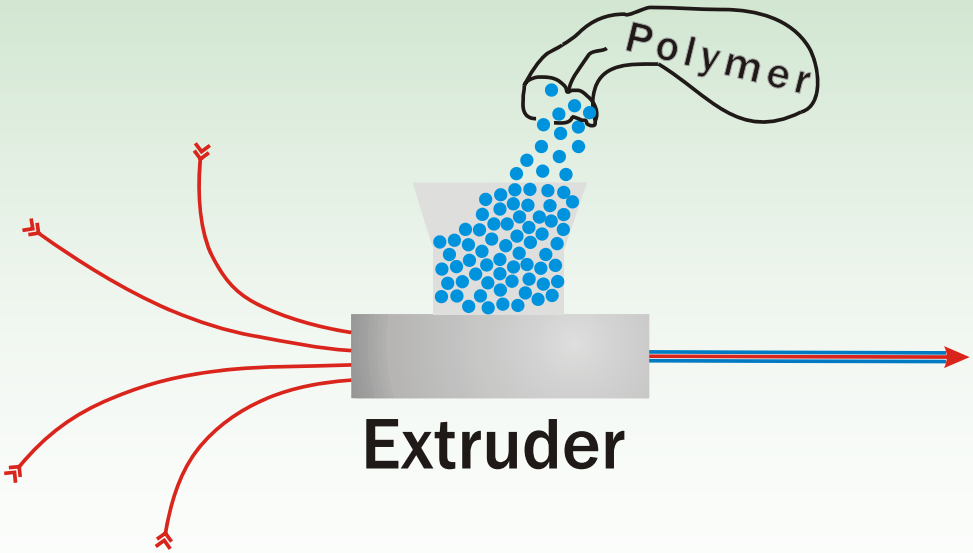


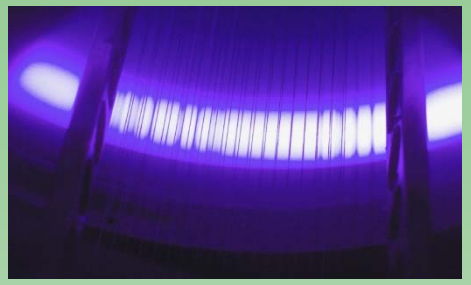
PLA

- Biobased polymer
- Thermoplastic
- Aliphatic polyester
- Biodegradability
- Sustainable nature



Antimicrobial polylactide

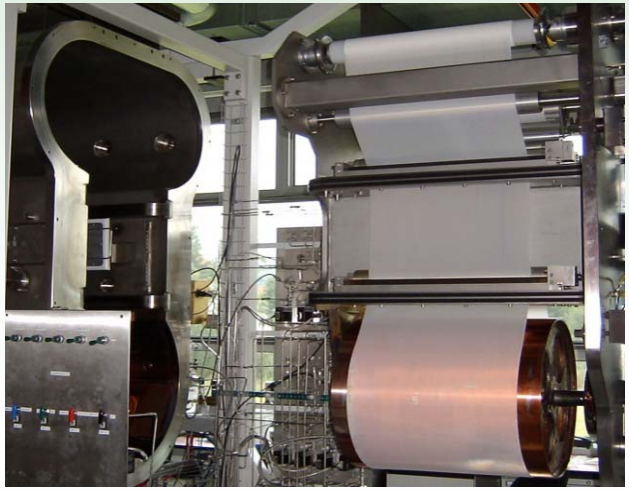
- Surface modification with silver
- Antimicrobial properties
- Food contact applications
- Medical and specialized textiles



Surface modification - Magnetron sputtering

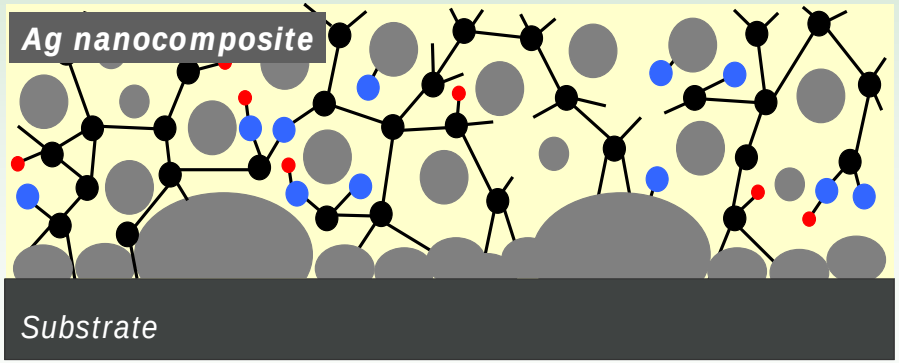
- Silver layers of thickness (10-20 nm) were deposited on the surface of PLA films using DC magnetron sputtering (99.99% pure Ag target).

. Untreated Ablation/cleaning Functionalization Metallization



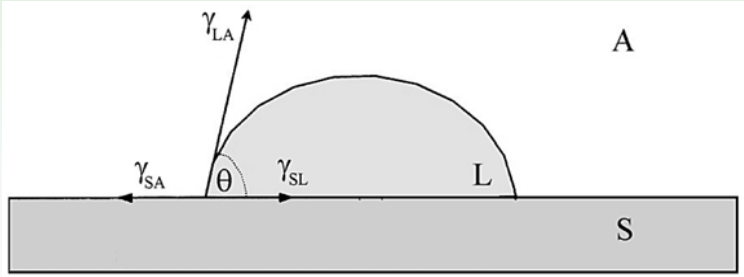
Surface modification – Low pressure plasma

- PLA surfaces were also modified by use of simultaneous plasma polymerization/ sputtering technique to deposit 25 nm-thick nano-composite thin films (Ag nanoparticles embedded in a-C:H:O plasma polymer matrix).

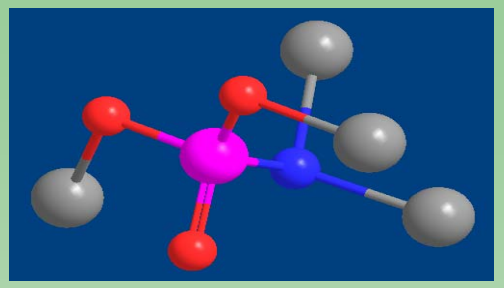


Contact angles

- Wettability of the modified PLA films was determined by measuring contact angles (CA) using deionised water (20 µl). The measurements were performed by a sessile drop method (Fig. 4.) using a microscope equipped with a horizontal light path and a goniometric eyepiece (Krüss, Germany) [11].



Schematic representation of contact angle (Ɵ) formed between the tangent drops of liquid (L-liquid), solid surface (S-solid) and ambient air (A - air).



Silver release

- Silver release of different coatings on the PLA films was investigated by using Inductively Coupled Plasma – Optical Emission Spectroscopy

- A sample size of 5X5 cm was taken for elemental analysis and silver concentrations were measured for blank sample, films after treatments with 5 ml ethanol for 1hr and for after 18 h in 5 ml media Tryptic Soy Broth:NaCl (1:500).

Determination of antibacterial activity

- Antimicrobial activity of PLA films were measured against Gram-positive bacteria *Listeria monocytogenes* and two Gram-negative bacteria *Salmonella typhimurium* .

- The antibacterial activity could be calculated according to the equation:

$$\log \text{reduction} = \log (A) - \log (B) \quad (1)$$

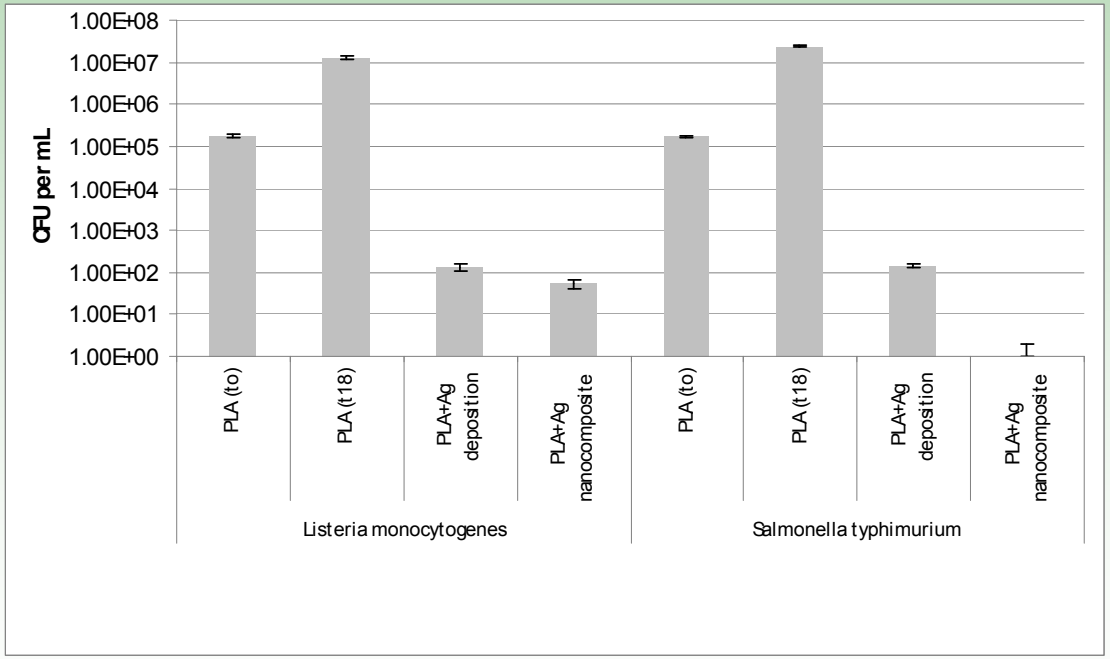
where: A = initial count of microorganisms of the control sample,

B = number of microorganisms detected at a given biocide concentration after a specific contact time

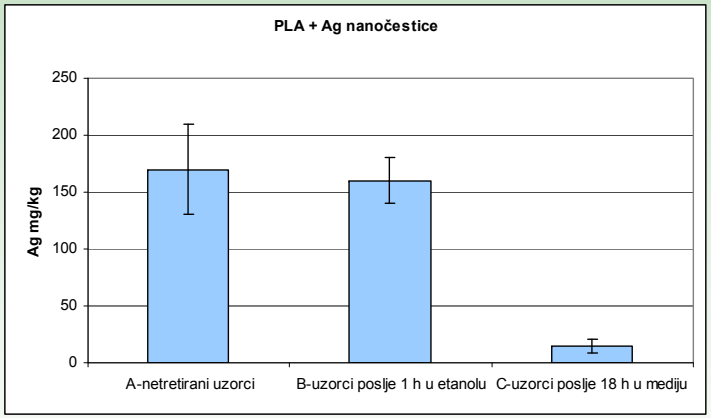
Results

- Surface modifications with silver, either as pure silver deposit or as silver nano-composite improve the hydrophillicity of unmodified film (70°) to 24° for modified PLA. The wettability of plasma-treated films is improved significantly due to the formation of polar groups on the surface.
- The two tested bacteria, applied in the study , *Listeria monocyto*genes and *Salmonella typhimurium*, were very sensitive to the silver modified PLA surfaces > 4 log reduction or 99,99 %.

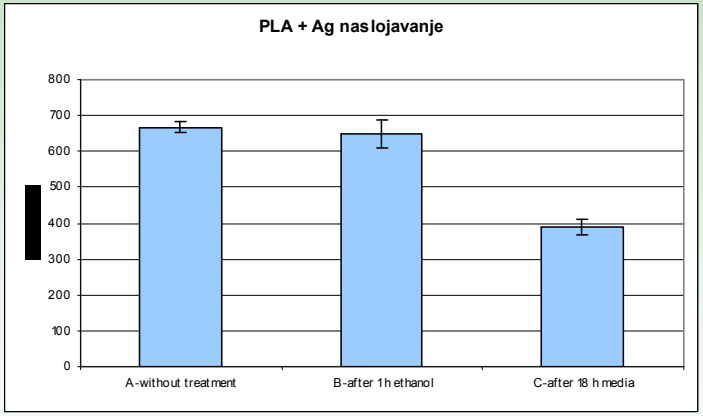
Antimicrobial activity of PLA materials with surface modification



Silver release from PLA films quantified by ICP-OES:



a) PLA – Ag nanocomposite



b) PLA –Ag sputtered process

The release of silver from the surfaces was significantly higher in the case of samples with Ag nano-composite thin films.

Conclusions

- Silver is a well recognized antimicrobial agent and surface modifications with silver, either as pure silver deposit or as silver nano-composite, significantly improve the antimicrobial properties of PLA films.
- The modified PLA films were particularly efficient against *Listeria monocyto*genes and *Salmonella typhimurium* bacterias and they might find their future application in biomedical and food packaging areas.
- Films which were treated simultaneously by plasma polymerization/sputtering technique (Ag nano-composite thin films) exhibited better effectiveness against used bacterias, than the pure silver deposit.

Acknowledgement

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