PlasmaTex

Novel type of antibacterial coatings on textile materials and plastics with controllable release of antibacterial agent"

Romanian Research contract No: 32/2016

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Abstract:

New generation of medical textiles and plastics are of extreme interest from industry and health care sector. Among others the most demanding sector is production of innovative materials with controllable antibacterial properties. In the PlasmaTex project a new class of antibacterial coatings for medical textiles and plastics will be developed. The proposed approach is to use a layered coating with a layer containing Ag nanoparticles and an additional barrier layer for controlled release of the antibacterial agent. The coatings are deposited by atmospheric pressure plasma, a versatile technique that allows producing uniform high quality coatings on almost any material.
The research issues that will be addressed in the project include the detailed physical chemistry of the plasma-assisted deposition process and the release mechanism of the antibacterial agent through the barrier layer. Advanced plasma, surface and microbiological diagnostics will be deployed to establish a

relationship between process parameters and coating performance. The gained knowledge will be applied to define a scalable coating methodology that yields nanocomposite coatings with superior antibacterial efficiencies.

Objectives and expected results

The main objective of the project is to investigate new class of antibacterial coatings for medical materials. It focuses on plasma assisted deposition of composite nano-coatings on textiles and plastics with possibility to control the release of the antibacterial agent by the use of barrier layers. The work oriented along the value chain focuses on medical textiles with improved antibacterial properties efficiencies and on the up-scaling of environmental friendly and energy effective plasma process. This is complemented by a range of activities from strategic basic research of plasma deposition process and investigation of new class of coatings to tests of new materials and their properties and up-scale of the system.

On the way to achieving the goals of PlasmaTex, a number of scientific objectives can be identified:

1. Investigation of the polymers matrix used for the Ag-composites preparation by variation of precursor: chitosan, hexamethyldisiloxane, poly(vinyl alcohol), mixtures

2. Plasma deposition of Ag containing composites with variation of Ag content on medical grade plastics: polyethylenethereftalat, polyamide, and polyurethane

3. Plasma deposition of nano-composites on medical textiles: woven and non-woven fiber based fabrics

4. Investigation of barrier layers deposition with controllable thickness of 5-50 nm on top of composite coatings

5. Analysis of chemical and structural properties of the deposited coatings

6. Effect of Ag content and presence of the barrier layer on release of Ag ions from the coatings

7. Investigation of mechanical, functional and antibacterial properties of the plasma modified textiles and plastics

8. Adaptations of the system to industrial requirements (safety issues, automation, deposition control, speed of the process, stability of work)

9. Up-scale of the system (reel-to-reel process, 65 cm width) with evaluation of the performance and costs estimations

Successes of PlasmaTex project will contribute to deeper understanding of nano-composite coating properties and wider adoption of a plasma deposition technique for medical materials manufacturing, as an alternative to used nowadays wet chemistry processes having numerous drawbacks.

DAVO's role in the project

Based on the knowledge acquired in previous projects related to antimicrobial textiles, DAVO will provide expertise regarding the identification and selection of the different types of medical textiles (polymeric or mixtures, woven or non-woven fabrics) used as substrates for plasma coatings. Using the plasma source developed in PlasmaTex and installed at DAVO, we will perform tests on the selected fabrics according to the guidelines provided by the partners, in a reel-to-reel set-up. The research at DAVO will be focused on the influence of the substrate material on the coatings adhesion and on the attained antibacterial effect. In the phase of upscaling the plasma source to industrial demands, the company will provide partners specific information, based on data obtained previously in the present project and also considering the expertise gained upon implementation of sonication line for nanocoating of medical textiles, in order to insure for the plasma techniques the best processes in terms of antibacterial textile quality and economic outcomes.

Added value provided to the project by DAVO

DAVO will bring to the Consortium the infrastructure as well as the experience previously gained in EU projects in the field of medical textiles, and in particular those with antibacterial properties, and will fully cooperate with the consortium in order to achieve the proposed tasks. On the other hand, DAVO will broaden its expertise in the field of nanocoatings by adding new skills related to plasma based techniques, apart from those already implemented based on sono-chemical processing of textiles.

Equipment

As part of the SONO project, DAVO has installed at it's facility an ultrasound pilot machine used for nanoparticle coating on fabrics.

The ultrasound machine has two main components with the following characteristics:

a. Sonochemical tank

volume of sonochemical tank:	10,5 – 14 Litres
width of the treated fabric:	no more then 500mm
average speed of the fabric:	0,1 – 2,2 meters/ min
power supply:	3×380 V

Condition of exploitation:

ambient air temperature	10 – 35 Celsius
relative air humidity:	not more than 80%

b. Ultrasonic generator

The ultrasonic generator is designed to supply ultrasonic magnetostrictive transducers (found in

the sonochemical tank). The generator has the fallowing features:

operating frequency: 21 – 24 kHz
maximum output power: 10 kW
measurement error of frequency: no more than 1%

Project status (June 2017)

Stage 1: Identifing the different types of fabrics to be used in the fututre expirents.
End date: 31.12.2016

Stage 2: Analizing the impact of wear and wash on the release of nanoparticles
End date: 31.12.2016
Deliverable: D4.3 "An overview of the coatings performance for medical applications: efficiency, possible use in medical application"

Participation in meetings and workshops

a) 2nd Project meeting PlasmaTex, 7-9 November 2016, Magurele Bucharest, Romania Venue: National Library for Physics, Magurele, Romania

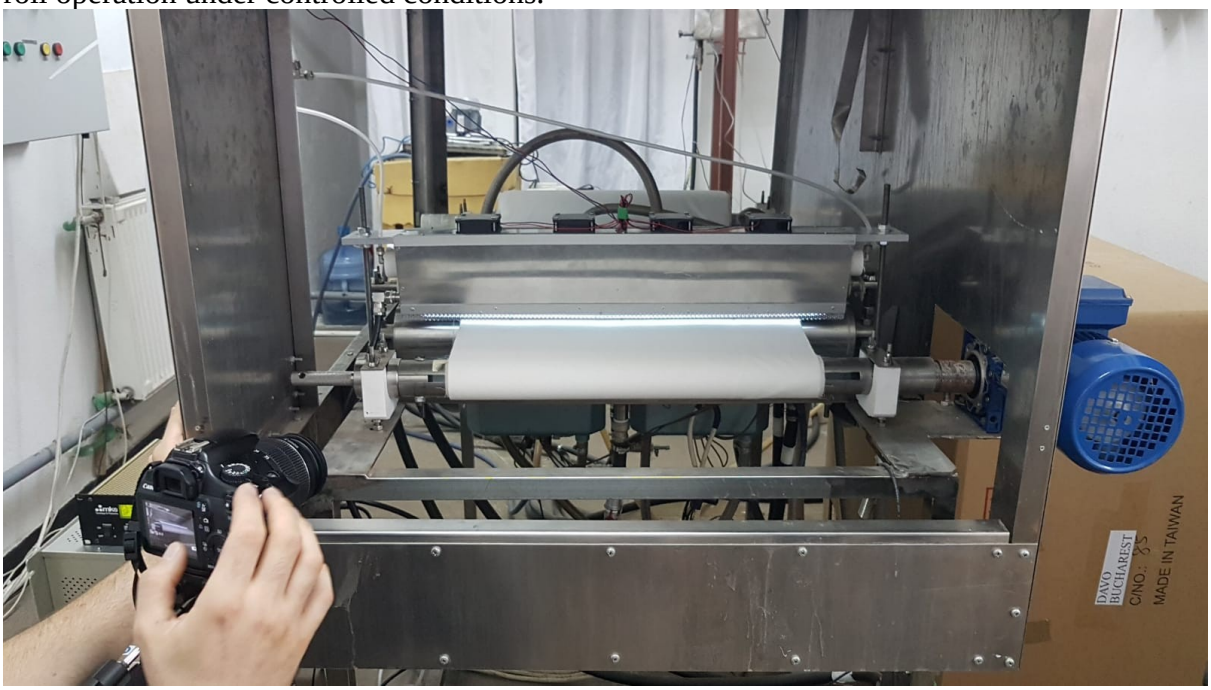
b) 1st Workshop on Plasma Coatings for Medical Applications, 17th June 2017, Magurele Bucharest, Romania Venue: Conference Hall IFIN-HH

c) 4th Project meeting PlasmaTex, 17th June 2017, Magurele Bucharest, Romania Venue: Conference Hall IFIN-HH

d) Working visit together with project partners at INFLPR center , 7-9 November 2016

Project Status 3rd Stage (December 2018)

In 2018, the activity was carried out in accordance with Stage 3 of the PLAN OF IMPLEMENTATION:
Designing, developing and demonstrating the functionality of the plasma system for continuous roll-to-roll operation under controlled conditions.



The result of the research phase consisted of integrating and testing the plasma deposition system for operation on a roller-drum system under controlled conditions.

The DAVO objectives of the PlasmaTex Project for 2018 have been met:
• All the necessary preparations and adaptations were made for the integration of the sonification pilot station in our facility with the scaled plasma reactor made by the specialists from the Institute of Plasma Physics of Magurele, our partners in this Project;
• Following the workshops between the INFPL di DAVO specialists, the risks of explosions, fires and radiation possible during work with the Plaster Station for Textile Surface Treatment were identified. All existing protection systems at the location of the machine have been checked and reviewed;
• All devices required to integrate the plasma equipment installation into the existing pilot station were

made. All the materials needed to test the operation of the new pilot station have been purchased. Plasma-treated fabric samples were submitted for analysis to the INCDTP. The results are presented in the Annexes;
• The real-time tracking of fabric production of antibacterial-treated fabrics in the plasma was re-evaluated and adapted to the new work system;
• An analysis of the market demand for smart textiles has been carried out taking into account the fact that our country has an important tradition in the textile industry.
Participation in meetings and workshops:
• CENTEXBEL - Gent, Belgium.
The trip took place between 04.02.2018 - 07.02.2018 with the purpose of analyzing the results obtained during the period 2016 - 2017. There was also an exchange of information between the partners involved in the project establishing the directions and objectives for the year 2018. Participating from DAVO to the meeting was Anton Radu Costin.

• Minho - 2C2T (Center of Science and Textile Technology) based in Guimaraes, Portugal.
The trip took place in the period 02.09.2018 - 04.09.2018. Discussions focused mainly on the stage of plasma source development for treating textile materials. The 2C2T specialists presented the plasma treatment plant that is installed and functional at their headquarters. DAVO attended this meeting with Anton Radu Costin.

Conclusions

We can state that from the DAVO's point of view all project objectives have been achieved.
• Textiles that were used for plasma deposition have been identified and selected. These materials were physically and mechanically characterized by laboratory tests conducted at INCDTP Bucharest.
• Physical-mechanical tests were performed on Ag-treated plasma fabrics and compared with the results of the same untreated fabrics.
• All the necessary preparations and adaptations were made in the pilot sonification station existing in our facility for the integration of the plasma reactor made by the specialists of INFLRP, our partners in the project.
• A market analysis of the growing demand for smart textiles, especially in the medical sector, and the opportunity to produce such articles, taking into account our country's tradition of textile production, has been carried out.