

SCIENTIFIC AND TECHNICAL REPORT

Program 2: Increasing the competitiveness of the Romanian economy through research, development and innovation

Subprogram 2.1. Competitiveness through research, development and innovation

Project type: Experimental – demonstrative project – PED

Project name: Improved technologies for the development of electrospun polysulfonic membranes integrated in an extracorporeal device applicable in renal failure

Contract no: 579PED/2022

Project code: PN-III-P2-2.1-PED-2021-2700

Project acronym: TechMembrEID

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Partner: Polytechnic University of Timisoara

Project director: Dr. Anca Filimon

Stage 1 (2022) – Formulation and development of bioactive functionalized fibrous membranes (FHMs) and designing of an innovative extracorporeal device (EID)

Reporting period: July – December 2022

Summary of the stage

The general objective of the TechMembrEID project aims at the design and development of an innovative extracorporeal device (EID, demonstrative model for TRL4 technology level) with integrated membrane module - bioactive fibrous membranes based on quaternized polysulfone - (FHMs, experimental demonstrator of TRL3 technological level) for application in hemodialysis (HD) processes, starting from a technological concept formulated at TRL2 level. According to the implementation plan of the project, phase I includes research on obtaining of new biomaterials used for the development of membranes applicable in renal failure. Thus, in **2022**, researches regarding the optimization of the properties in solution have begun in order to formulate/design and obtain biocompatible fibrous membranes based on functionalized polysulfone that will be integrated and used as separation media in an innovative extracorporeal device (EID). To achieve this objective, **Stage 1** was based on following activities:

Activity 1.1 - *Establishing the optimal electrospinning conditions by optimizing the obtained rheological parameters*

Activity 1.2 - *Obtaining the biocompatible fibrous composite membranes*

Activity 1.3 - *Obtaining the biocompatible functionalized fibrous membranes based on quaternized polysulfone (FHMs) by incorporating antioxidants*

Activity 1.4 - *Setting the Innovative Extracorporeal Device (EID)*

Activity 1.5 - *Dissemination*

Within the **activity 1.1 of the fundamental research type**, the composite systems based on polysulfone chemically modified with quaternary ammonium groups (PSFQ), cellulose acetate phthalate (CAP) and polyvinylidene fluoride (PVDF) were made and studied from the perspective of the conformational characteristics optimization under the influence of different factors (composition, concentration, etc.), for future use in the obtaining of fibrous membranes with superior performances to those already known, suitable for medical applications. In first stage, the rheological parameters were controlled and evaluated in correlation with the structural particularities of the polymers from the system and depending on the nature of the used solvents/solvent system. The study note the influence of the flexibility/hydrophilicity of the polymers involved and the interactions that occur in the system, so that the examination and control of the rheological parameters are really important and allowed the establishment of the optimal electrospun conditions for the formulation and successfully obtaining of the fibrous materials that modulate the properties of hemodialysis membranes.

Activities 1.2 and 1.3 of the experimental development type allowed the modeling/development of new bioactive membrane materials with increased efficiency in the hemodialysis processes through the optimal combination of the properties of the composites containing PSFQ (with controlled structure, chemical stability, mechanical resistance, etc.) and CAP with those of polyvinylidene fluoride (**activity 1.2**) and antioxidants (α -lipoic acid, α -tocopherol) (**activity 1.3**). In this context, through the proposed approach, the improvement of the characteristics and operational performance of the functionalized biomembranes was achieved, minimizing the disadvantages of their individual use in hemodialysis (for example, the limitation or reduction of the negative effect during the HD therapy, elimination of the harmful effect of the produced free radicals during HD therapy). Thus, the methodology and processing technique of the electrospinning composite solutions based on quaternized polysulfone (obtained by mixing in different ratios the selected components: polymers (PSFQ, CAP, PVDF) and antioxidants (α -lipoic acid, α -tocopherol)) led to the obtaining/development of the fibrous membranes with properties adapted for practical applications (uniform, continuous fibers, without "beads", high flexibility, well-defined pores).

Development in the laboratory of an experimental demonstrator has constituted one of the necessary prerequisites for the experimentation of some HD processes in an extracorporeal device proposed within the project (**activity 1.4**). Thus, the design/configuration of the innovative extracorporeal device (EID) in which the bioactive fibrous membranes (FHM)s will be integrated was create to work in optimal conditions of application of hemodialysis processes and to fulfill the expected functionality and performance of the entire assembly.

At **activity 1.5 of support type** all members of the consortium have participated. It was elaborated 1 scientific paper sent for publication to an ISI journal and 2 two papers were presented at international conferences. For project promotion and dissemination of his results, the website of the TechMembrEID project was created and updated (<https://icmpp.ro/techmembreid/>).

ISI papers:

1. Electrospun nanofibers based on polymer blends with tunable high-performance properties for innovative fire-resistant materials, D. Serbezeanu, C. Hamciuc, T. VladBubulac, M.D. Onofrei, A. Bargan, D. Rusu, D.M. Soul, G. Lisa, *Polymers* (in evaluation)

Scientific manifestations:

1. A.M. Dobos, M.D. Onofrei, D. Serbezeanu, L. Lupa, A. Filimon, Polysulfone-based composite fibrous membranes: Influence of the solution parameters on the electrospinning process, *New Trends and Strategies in the Chemistry of Advanced Materials with Relevance in Biological Systems, Technique and Environmental Protection*, Timisoara, Romania, **20-21 October, 2022 (poster)**
2. A. Filimon, D. Serbezeanu, A.M. Dobos, M.D. Onofrei, D. Rusu, L. Lupa, Role of the solvent in electrospinning process of fibrous materials based on polysulfone, *28th International Symposium on Analytical and Environmental Problems*, Szeged, Hungary, **14-15 November, 2022 (poster presentation)**

The implementation team has fulfilled the tasks stipulated in the project for this stage, so that all the proposed activities were carried out.

Project manager,

Dr. Anca Filimon