FUNDING PROGRAMME: ERANET-COFUND-MANUNET III &
PNCDI III, European and International Cooperation
SUBPROGRAME: 3.2 - Horizon 2020

PROJECT TITLE /ACRONYM:
Manufacturing textiles with electromagnetic shielding and fire retardant properties by plasma based methods-TexEMFiRe

CONTRACT NO.:
UEFISCDI contract no. 28/2018 and FINPIEMONTE Prot. no. 0007033 din 12/03/2018

TOTAL PROJECT BUDGET: 1.181.180 RON (Ro Partners) **INCDTP'S BUDGET:** 409.500 RON

PROJECT STARTING DATA: 01/04/2018 **PROJECT ENDING DATA:** 30/09/2020

PAGINA WEB: http://texemfire.inflpr.ro/

PARTNERS:

National Institute for Lasers, Plasma & Radiation Physics – INFLPR, Romania – Coordinator

National Research and Development Institute for Textiles and Leather – INCDTP, Romania – P1

SC. MAJUTEX S.R.L., Bârnova, Iași, România – P2

Tecnolab del Lago Maggiore S.R.L., Piemonte, Italia – P3

Università degli Studi del Piemonte Orientale "Amedeo Avogadro", Piemonte, Italia – P4

GENERAL OBJECTIVES:

1. Design and manufacture innovative textile materials with metallic and insulating (fire-proof) barrier layers;
2. Investigate electromagnetic shielding and fire-retardant properties to demonstrate the improved multi-functionality;
3. Optimize the plasma process and material properties to insure reduced operation costs;
4. Provide an exploitation and business plan based on LCA studies ready to use in the manufacturing textile industry.

EXECUTION PHASES:

Phase I. Design, manufacture, plasma treatment and characterization of textile with electromagnetic and fire-retardant properties

Period: April - December 2018

Phase II. Optimization by modelling and experimentation of plasma treatment processes applied to textile materials to obtain multiple functionalities of electromagnetic attenuation and fireproofing (EMFiRe)

Period: 2019

Phase III. Life Cycle Assessment and elaboration of a business and exploitation plan in the field of manufacturing flame retardant textile materials with electromagnetic attenuation properties for Buildtech (EMFiRe)
Period: January – September 2020

NOVELTY ELEMENTS:

The electromagnetic shielding effectiveness is improved with 10 dB, by magnetron plasma coating of a metallic layer in the range of 400-1200 nm, on both sides of a textile shield with inserted metallic yarns in warp and weft and achieves values of 60 dB. This result is "very good" according to the regulations of flexible electromagnetic shields for civil and professional use. Good fireproof results were obtained by polymerization of Apyrol in atmospheric plasma on the surface of the textile substrate.

EXPECTED EXPLOITABLE RESULTS:

Implementing into the production process of SC Majutex SRL of flexible electromagnetic shields made of woven structures, with applications in the technical textile domains Buildtech and Protech.

OBTAINED RESULTS:

1. Study regarding the interaction between electromagnetic waves (EM) and the structure of textile materials functionalized with metallic and fireproof layers used in EM shielding
2. Comparative LCA study regarding electromagnetic and fireproof shields, obtained by classical and plasma magnetron processes
3. Manufacturing technology of textile shields from woven structures with metallic yarns and metallic plasma coating in the range of hundreds of nanometres
4. Products of textile electromagnetic and fireproof shields based on woven structures – 5 variants

DISSEMINATION, PATENT APPLICATIONS, AWARDS:

- **WoS published papers: 4**

1. I.R. Radulescu, L. Surdu, C. Morari, B. Mitu, M. Costea, N. Golovanov, Conductive textile structures and their contribution to electromagnetic shielding effectiveness, Industria Textila 5/2020, ISSN 1222–5347 (ISI).
2. L. Surdu, I.R. Rădulescu, E. Visileanu, C. Stancu, A. Ardeleanu, I. Sandulache, C. Mitran, B. Mitu, Research regarding the cover factor of magnetron sputtering plasma coated fabrics, Industria Textila ISSN 1222–5347 2/2019.
3. I.R. Rădulescu, E. Visileanu, I. Pătru, L. Surdu, M. Costea, V. Voicu, Modelling and testing the electromagnetic near field shielding effectiveness achieved by woven fabrics with conductive yarns, Industria Textila 69 (3) (2018) 169–176.

- **SCOPUS published papers: 1**

1. **I.R. Radulescu, L. Surdu, R. Scarlat,** C. Constantin, B. Mitu, C. Morari, M. Costea, Modelling the Woven Structures with Inserted Conductive Yarns Coated with Magnetron Plasma and Testing Their Shielding Effectiveness. , MDPI - Textiles 2021, 1, 4-20. https://doi.org/10.3390/textiles1010002.

- **BDI published papers: 4**

1. **I.R. Radulescu, L. Surdu, E. Visileanu, R. Scarlat,** C. Constantin, C. Morarl, B. Mitu, Influence of plasma coated woven fabrics yarn's density on electromagnetic shielding effectiveness, Annals of the University of Oradea, Fascicle of Textiles, Leatherwork Vol. 21, 1/2020.
2. **L. Surdu, I.R. Rădulescu,** B. Mitu, Research regarding achievement electromagnetic shields based on textile substrates, Buletin AGIR 3/2019.
3. **L. Surdu, E. Visileanu, I.R. Rădulescu,** Metode noi de investigare pentru determinarea caracteristicilor materialelor textile funcționalizate, Buletinul AGIR An XXIII nr. 3/2018, 42-45.
4. **I.R. Rădulescu, L. Surdu, E. Visileanu,** M. Costea, B. Mitu, Ecranarea câmpului electromagnetic apropiat prin structuri textile țesute, Buletinul AGIR, An XXIII, nr. 3/2018, 46-50.

- **Scientific communications: 18**

1. **L. Surdu, I.R. Rădulescu,** B.Mitu, C. Morari, Copper and stainless steel plasma coated woven fabrics for EMI shielding, CPPA2021 - 19th International Conference on Plasma Physics and Applications, Book of Abstracts, August 31- September 3 2021, Magurele, Romania, pp.48 (oral presentation, O16).
2. **I.R. Radulescu, L. Surdu, E. Visileanu, I. Sandulache**, C. Morari, B. Mitu, The gain in shiedling effectiveness achieved by superposition of stainles steel plasma coated woven fabrics, The 10th International Conference Texteh 2021, Online event - 21 - 22 October 2021.
3. **I.R. Radulescu, E. Visileanu, R. Scarlat,** B. Mitu, Comparative life cycle assessment study for fabric based electromagnetic shielding, ICAMS 2020 – 8th International Conference on Advanced Materials and Systems.
4. **I.R. Radulescu, L. Surdu, E. Visileanu,** B. Mitu, A. Ardeleanu, V. Satulu, M. Badic, C. Morari, Electromagnetic shielding achieved by plasma coated fabrics - AUTEX2019 – 19th World Textile Conference on Textiles at the Crossroads, 11-15 June 2019, Ghent, Belgium.
5. **L. Surdu, I.R. Rădulescu**, B. Mitu, Electromagnetic Shielding out of plasma coated woven fabrics, TexTeh IX, 24-25 October 2019, Bucharest, Romania (poster presentation).
6. **L. Surdu,** A. Ardeleanu, **E. Visileanu, I.R. Rădulescu,** M. Badic, C. Morari, B. Mitu, Fabrics for Buildtech electromagnetic shields based on plasma magnetron sputtering, TexTehIX, 24-25 October 2019, Bucharest, Romania (oral presentation).
7. A.A. Ardeleanu, C. Stancu, **L. Surdu, E. Visileanu, I-R. Radulescu,** M. Badic, C. Morari, B. Mitu, Fabrics with electromagnetic shielding properties achieved by magnetron sputtering deposition, XVIII International Conference on Plasma Physics and Application, 20th–22nd June 2019, Iasi, Romania (poster presentation, P3-18).
8. G. Rombola, V. Gianotti, M. Milanesio, L. Palin, E.A. Basso, M. Setaro, **L. Surdu,** B. Mitu, LDH/POSS nanoadditives for improved fire resistance in cotton textiles, Industrial Workshop on Recent Advances in Technical textiles, TexTehIX, 25th October, 2019 (oral presentation).
9. V. Satulu, B. Mitu, **I.R. Radulescu, R.M. Aileni,** G. Dinescu, Preparation of superhydrophobic cotton fabrics based on fluorocarbon compounds by plasma methods, poster ID 512, 24th International Symposium on Plasma Chemistry (ISPC 24), Sunday – Friday, 9 June – 14 June 2019, Naples.
10**. L. Surdu, R.M. Aileni, R.I. Radulescu, L. Chiriac,** Research regarding electromagnetic shielding achieved by the fabrics support, 7th Edition of the International Conference on Intelligent Textiles & Mass Customisation - ITMC 2019 / Smart Textiles Salon Vol.7 – STS 2019- November 13-15, 2019, Marrakesh, Morocco (oral presentation).
11. **L. Surdu, R.M. Aileni, R.I. Radulescu, L. Chiriac,** B. Mitu, Fabrics with electromagnetic shielding properties achieved by magnetron sputtering deposition, Technical Textiles - Present and Future Symposion; Iasi; Romania, November 15, 2019 (poster presentation).
12. **L. Surdu, I.R. Rădulescu,** B. Mitu, Research regarding achievement electromagnetic shields based on textile substrates, Simpozion AGIR – Progresul Tehnologic Rezultat al Cercetarii Ediția a XIV –a / 9 mai 2019 (oral presentation).
13. B. Mitu, V. Satulu, **R.I. Radulescu, L. Surdu,** G. Dinescu, Plasma deposition of textiles for obtaining electromagnetic shielding and fire-retardant properties, 16th International Conference on Plasma Surface Engineering, September 17 - 21, 2018, Garmisch-Partenkirchen, Germany (poster presentation).
14. **R.I. Radulescu, L. Surdu, E. Visileanu,** Fabric's testing and modelling for prediction of shielding effectiveness, VI Scientific – Vocational Conference with international participation: Development tendencies in the textile industry – Design, Technology, Management, 27.06.2018, Belgrade, Serbia (conference proceedings).
15. **L. Surdu, E. Visileanu, I.R. Rădulescu,** Metode noi de investigare pentru determinarea caracteristicilor materialelor textile funcționalizate, Simpozion PROGRESUL TEHNOLOGIC-REZULTAT AL CERCETARII, editia a XIII-a, București, 26 aprilie 2018.
16. **I.R. Rădulescu, L. Surdu, E. Visileanu,** M. Costea, B. Mitu, Ecranarea câmpului electromagnetic apropiat prin structuri textile țesute, Simpozion PROGRESUL TEHNOLOGIC-REZULTAT AL CERCETARII, editia a XIII-a, București, 26 aprilie 2018.

- **Patent Applications: 1**

Cerere brevet A00681/30.10.2020, "Un nou tip de structura compozita textil/metal cu proprietati de ecranare electromagnetica", autori: B. Mitu, Gh. Dinescu, T. Acsente, L. Surdu, I.R. Radulescu, I. Mancasi.

- **Book chapters: 2**

1. **I.R. Radulescu, L. Surdu, E. Visileanu,** B. Mitu, C. Morari, Life Cycle Assessment of flexible electromagnetic shields, DOI: 10.5772/intechopen.99772, Intechopen chapter in book Electromagnetic Compatibility, 2021.

2. **I. R. Radulescu, L. Surdu, E. Visileanu,** C. Morari, M. Costea, Modeling and Validating Analytic Relations for Electromagnetic Shielding Effectiveness of Fabrics with Conductive Yarns, DOI: 10.5772/intechopen.95524, Intechopen chapter in book Textiles for Functional Applications, 2021.

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