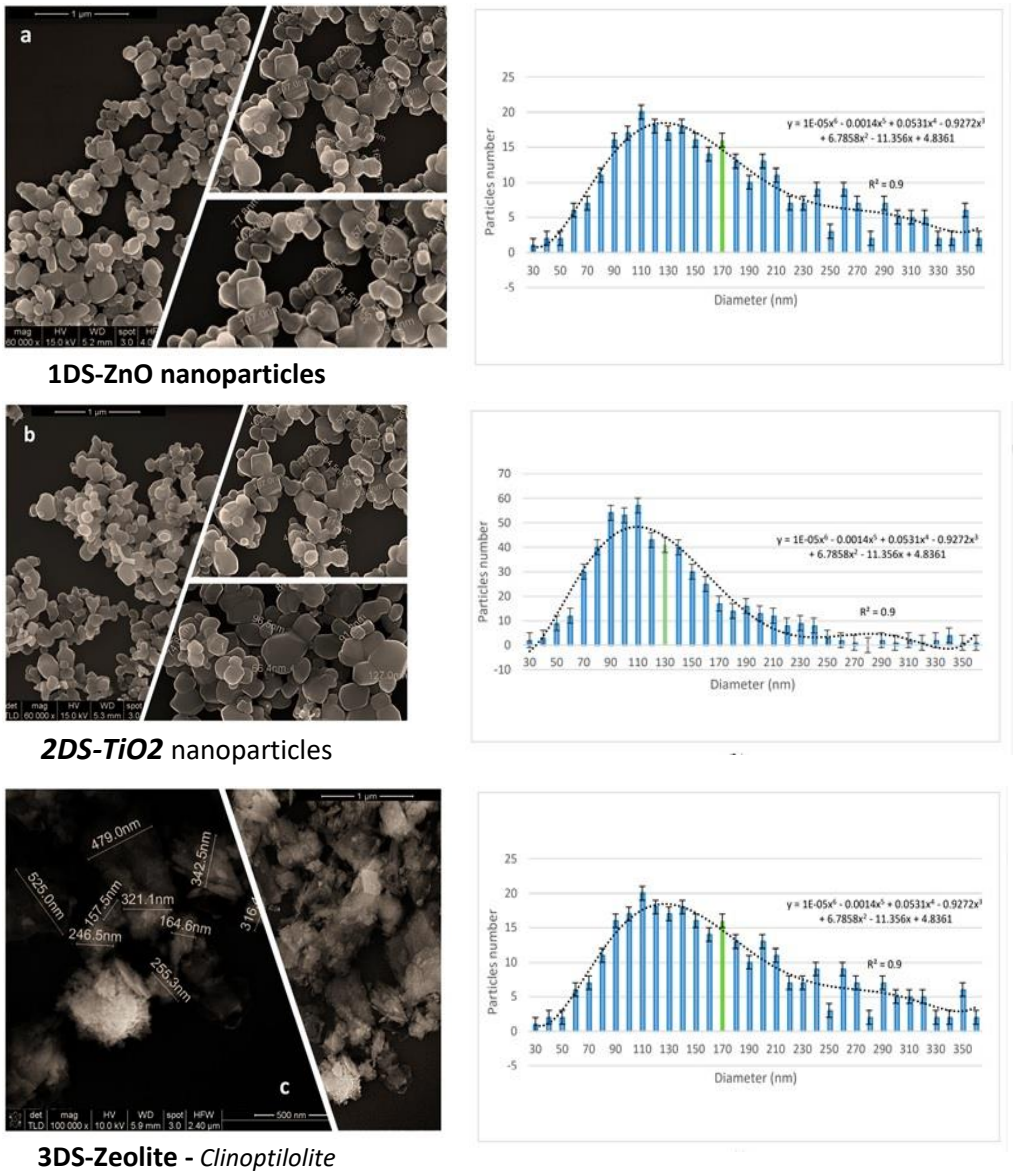
Results 2022

Evaluation of the chemical and biological decontamination efficiency of the demonstrator model, NANODEC RBC (TRL4) and validation its functionality.

➢ Chemical and biological decontamination efficiency was tested for three types of prepared solutions: ***1DS-ZnO ; DS -TiO2; 3DS –Zeolite.*** Characteristics of nanoparticles used in the three types of NANODEC RBC solutions are presented in Fig.1a, b, c and in Fig.2, the Raman spectrum of the prepared organic solution is presented, highlighting the Raman peaks (peaks from 367-475 cm^{-1} are characteristic of -C-C- chain vibrations, 205 cm^{-1} of the presence of NaOH, 800-1150 cm^{-1} are specific of -C-O-C bond vibrations; 819 cm^{-1} (C-H) and 1452 cm^{-1} indicate the presence isopropyl alcohol, 2800 to 2970 cm^{-1} are specific to C-H vibrations).



1DS-ZnO nanoparticles

2DS-TiO2 nanoparticles

3DS-Zeolite - *Clinoptilolite*

Fig. 1

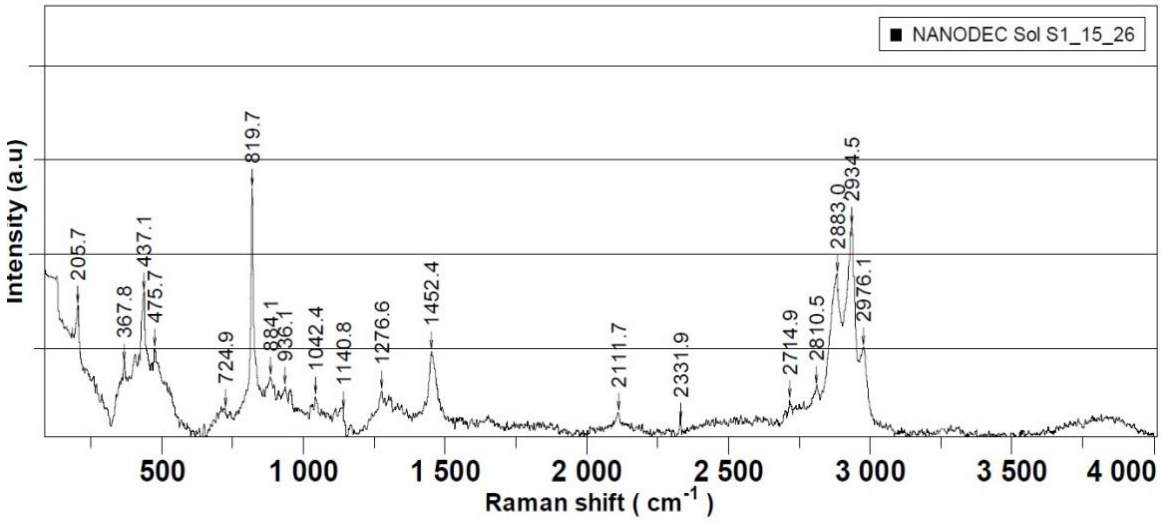
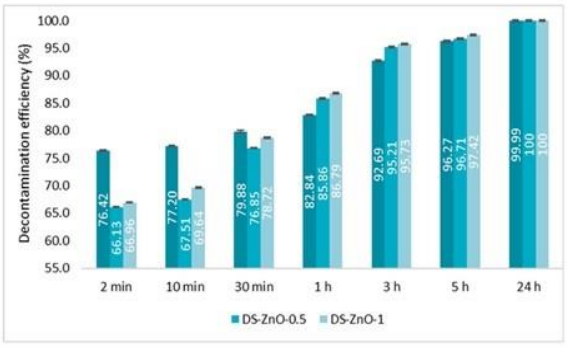


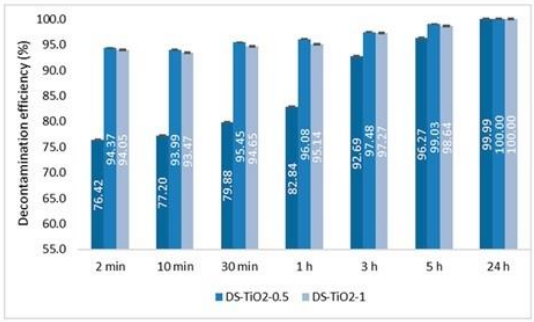
Fig. 2

- **Chemical decontamination efficiency of the NANODEC-RBC solution**

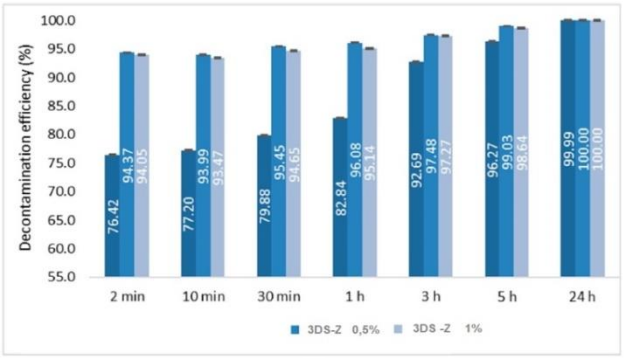
The decontamination efficiency was tested for all three types of solutions *1DS-ZnO, DS -TiO2 and 3DS –Z* and for two different concentrations of nanoparticles of 0.5% and 1% in the DS organic solution. The tests were carried out with mustard/HD and soman/GD toxic gas, in specialized laboratories from the partners P1/CCIA-CBRNE and P2/ATM. Fig. 3 and Fig. 4 respectively.



a)



b)



c)

Fig. 3. Decontamination efficiency at mustard/HD gas: a) 1DS-ZnO, b)2DS-TiO2 and 3DS-Z*.*

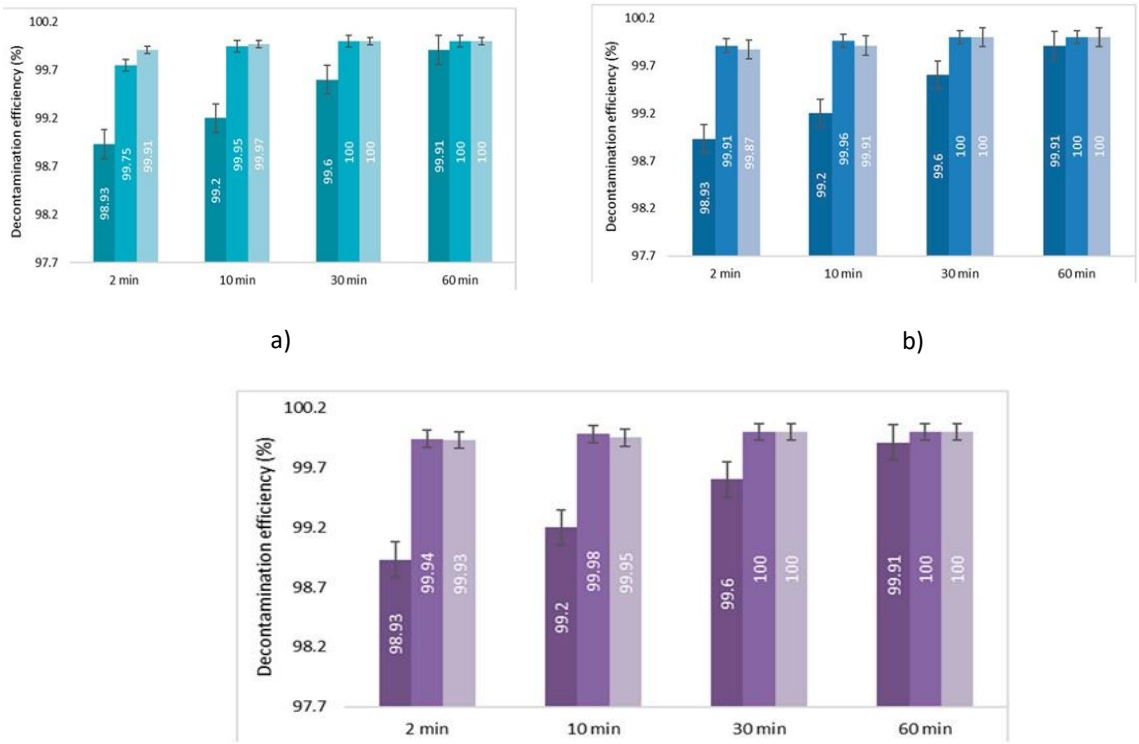


Fig. 3. Decontamination efficiency of NANODEC-RBC solution at soman/GD toxic *gas: a) 1DS-ZnO, b)2DS-TiO2 and 3DS-Z.*

- **Biological decontamination efficiency of the NANODEC-RBC solution**

The biological decontamination efficiency was tested on different surfaces: truck wheel (rubber), car hood (painted metal) and truck bar through their controlled contamination, Fig.4. These tests were carried out using microorganisms as contamination agent - Bacillus anthracis spores, Bacillus cereus, Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa. Table 1 shows the initial level of contamination on the three types of surfaces.

Table 1- Control of the initial level of contamination of the tested surfaces

Microorganisms	Painted metal (UFC/10 cm^2) *	Rubber (UFC/10 cm^2) *	Truck metalic bar (UFC/10 cm^2) *
Bacillus cereus spores	N**	31 x 10^3 ± 100.00	28 x 10^3 ± 86.60
Bacillus cereus	N**	25 x 10^3 ± 100.00	25 x 10^3 ± 50.00
Bacillus subtilis	N**	25 x 10^3 ± 50.00	19 x 10^3 ± 55.67
Staphylococcus aureus	N**	16 x 10^3 ± 124.90	27 x 10^3 ± 91.65
Pseudomonas aeruginosa	N**	22 x 10^3 ± 30.00	18 x 10^3 ± 124.00

*Initial microbial load was 104 CFU/10 cm^2; UFC=colony forming units; N**=too many colonies to count

Fig. 4 – The contaminated surfaces and the dispersion of the decontamination solution - NANODEC-RBC on the three types of surfaces - rubber (wheels), hood (painted metal) and metal bar.

The results obtained after the completion of the decontamination process are given in Table 2.

Table no. 2. Decontamination efficiency of the solution on various types of surfaces

Microorganisms	Painted metal (UFC/10 cm^2) *	Rubber (UFC/10 cm^2) *	Truck metalic bar (UFC/10 cm^2) *
Bacillus anthracis spores	<1	2 ± 1.00	1 ± 0.00
Bacillus cereus	N **	3.0 ± 1.00	3.5 ± 0.50
Bacillus subtilis	N **	1.7 ± 0.26	2.1 ± 0.17
Staphylococcus aureus	1.7 ± 0.26	1.1 ± 0.17	2 ± 1.00
Pseudomonas aeruginosa	N**	2 ± 1.00	1 ± 0.00

*Initial microbial load was 104 CFU/10 cm^2; UFC=colony forming units; N**=too many colonies to count

- **Dissemination**

The dissemination of the results obtained within the project was carried out both by publishing articles in journals and conferences and by organizing a workshop in the last stage of the project within the Military Technical Academy "FERDINAND I, P2 partner.

1. *„ Antimicrobial Activity and Degradation Ability Study on Nanoparticle-Enriched Formulations Specially Designed for the Neutralization of Real and Simulated Biological and Chemical Warfare Agents” ,* Pharmaceuticals 2022, 15, 97, Issue.1., https://doi.org/10.3390/ph15010097, Supplementary Materials: https://www.mdpi.com/article/10.3390/ph15010097/s1.
Authors: Raluca-Elena Ginghina, Gabriela Toader* , Munizer Purica*, Adriana-Elena Bratu, Claudiu Lazaroaie, Tudor-Viorel Tiganescu, Ramona-Elena Oncioiu, George-Ovidiu Iorga, Florina-Lucica Zorila, Mihai Constantin, Gabriel Craciun, Florin Comanescu, Cosmin Romanitan.
2. *„Film-Forming Polymeric Blends Designed for the Removal of Heavy Metals and Radionuclides from Contaminated Surfaces”,* 17th International Symposium “Priorities of Chemistry for a Sustainable Development” PRIOCHEM, Chem. Proc. 2022, 7, 88.

Authors: Alice Podaru, Gabriela Toader*, Daniela Pulpea, Traian Rotariu , Aurel Diacon , Edina Rusen, Andreea Moldovan, Raluca Ginghina, Florentina Alexe, Sorina Bajenaru, Ovidiu Iorga, Mihai Ungureanu, Florin Dirloman, Bogdan Pulpea and Lucia Leonat.

3.“Solution processed reduced graphene oxide thin films on glass substrate for photodection applications”, 13 th - Internation Conference on Physics of Advanced Materials -ICPAM'13, September 24-30 2021, Barcelona, 24.09.2021 – 30.0. 2021, Abstract Book ICPAM 13, pp.171-172.

Authors: Florin Comanescu, Cosmin Obreja, Munizer Purica

4. *Workshop NANODEC-RBC , organized in the last stage of the project within the Military Technical Academy "FERDINAND I”, P2 partner*. Were presented the results obtained within the project and a demonstration was carried out regarding the functionality of NANODEC-RBC for decontamination applications , of particular interest to companies active in the field of national security and defense.