# Institutul Național de Cercetare-Dezvoltare în Inginerie Electrică - ICPE SA



## Co<sub>x</sub>CrFeNiTi HIGH ENTROPY ALLOYS SYSTEM TARGETS FOR PHYSICAL DEPOSITIONS AND THEIR OBTAINING PROCESS

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#### **ABSTRACT**

The present invention relates to the development of high entropy alloys (HEAs) from the  $Co_x CrFeNiTi$  (x = 0,5; 1) system obtained by solid state processing and consolidated by spark plasma sintering (SPS), with the goal of manufacturing targets for the production of protective coatings by physical deposition technologies. The sintered deposition targets presented both a homogeneous structure, without cracks or pores that could affect the integrity of the material, and highperformance physical-mechanical and functional properties.

#### TECHNICAL PROBLEM

Factors such as wear, corrosion and more are currently a real problem in the industry, generating significant costs due to the repair or replacement of equipment and parts, thus promoting research focused on surface engineering and their improvement through various methods.

#### TECHNICAL SOLUTION

The present invention solves the disadvantages created by environments that present a high potential for wear of the surfaces with which they are in contact by creating targets from materials with tailored properties to be used for physical deposition.

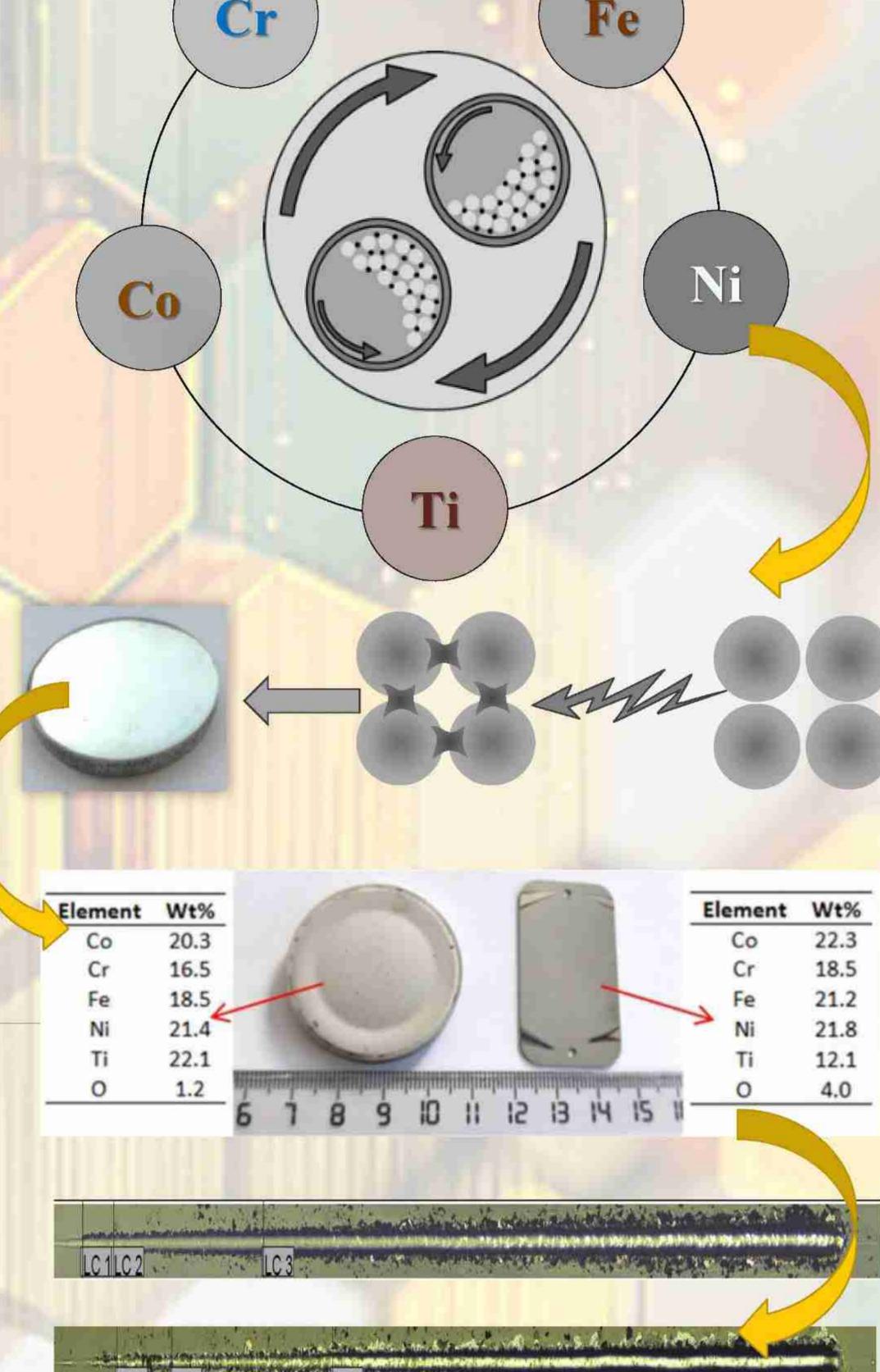
#### NOVELTY

The present invention indicates elements of technical progress by obtaining targets from high-entropy alloys  $Co_x Cr Fe Ni Ti$  with variable cobalt content (x = 0.5; 1) obtained by solid-state processing, followed by rapid and controlled consolidation of the alloyed powders by spark plasma sintering technology, and by using the resulting coatings with nearly stoichiometric composition compared to the sputtering target.

## ACKNOWLEDGMENT

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Code B: EQUIPMENT – INDUSTRIAL PROCESS - METALLURGY







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## RIVER WATER INTAKE WITH BEHAVIOURAL BARRIER TO REDUCE IMPACT ON FISH FAUNA

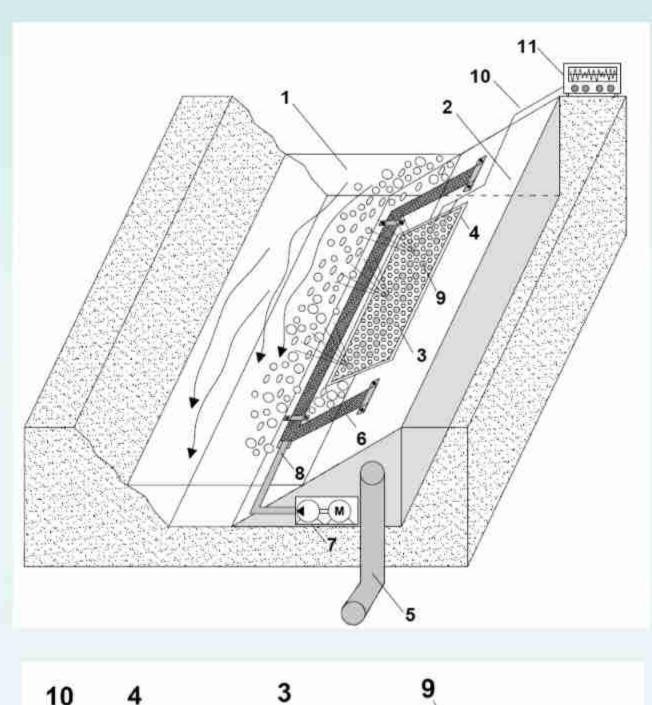
Authors: Gabriela CÎRCIUMARU, Rareș-Andrei CHIHAIA, Paul Alexandru DANCĂ, Andreea VOINA Patent application No. A/00357/2022

## **Novelty/ Description**

The invention relates to a water intake for rivers with a behavioural barrier to reduce the impact on fish fauna, used to capture water for the production of electricity or for the supply of drinking, industrial, irrigation or fish farming water. The river water intake has integrated a system for generating an air bubble curtain and an optoelectronic device for generating strobe light, which together create a behavioural barrier that prevents the accidental entry of small fish or fry through the intake openings.

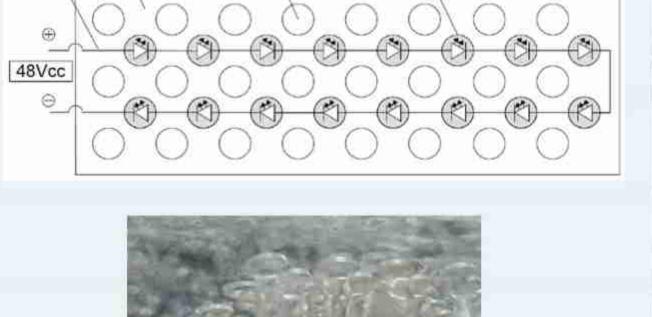
According to the invention, the river water intake with behavioural barrier is composed of the following main elements: a trapezoidal channel that follows the bed and slope of a river and an intake chamber, in which the water is taken through a perforated plate placed on a channel slope. The behavioural barrier integrated in the water intake is formed by a porous hose arranged on the perforated plate contour, supplied with compressed air and an optoelectronic device of LEDs placed in specific openings, with a dedicated control system.

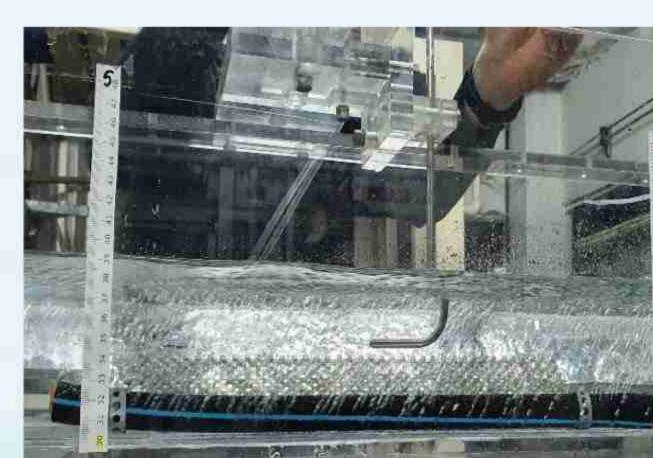
The solution works by projecting light onto bubbles in upward motion, in order to improve the reflection and dispersion of light, creating a much more visible and easily detectable barrier by fish.



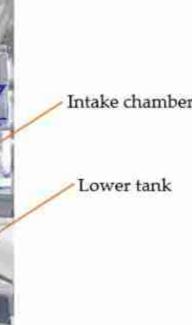
## Advantages:

- ☐ Compact solution that simultaneously performs two functions: water intake and fish diversion to avoid accidental capture;
- ☐ Follows the natural profile of the riverbed, ensuring longitudinal connectivity, fauna circulation in both directions and does not affect the microbiological system;
- ☐ The placement of the intake relative to the riverbed reduces the risk of silt blockage;
- Does not pose any risks to aquatic fauna or humans because it uses low voltage DC current;
- Does not require significant maintenance costs under proper operating
- conditions; Can be adapted to the specific characteristics of the location.









Laboratory validation of the river water intake using experimental model

## Applications:

- ☐ Water intakes for mountain rivers as an alternative for Tyrolean intakes suitable for small hydroelectric power plants;
- ☐ Suitable for rivers located in protected sites, where certain fish species are protected and require special attention in conserving their habitat.



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Code V. **Energy and Environmental** Protection

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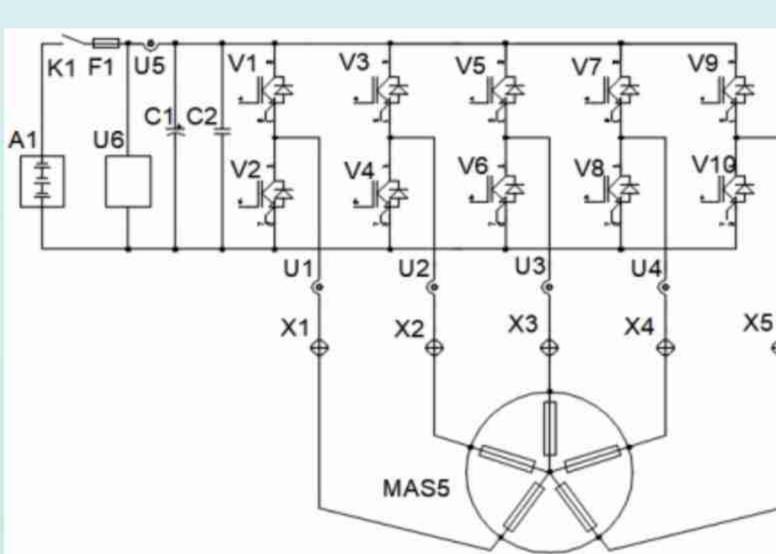


## Static converter for supplying five-phase induction motors and command method for the phase fault operation

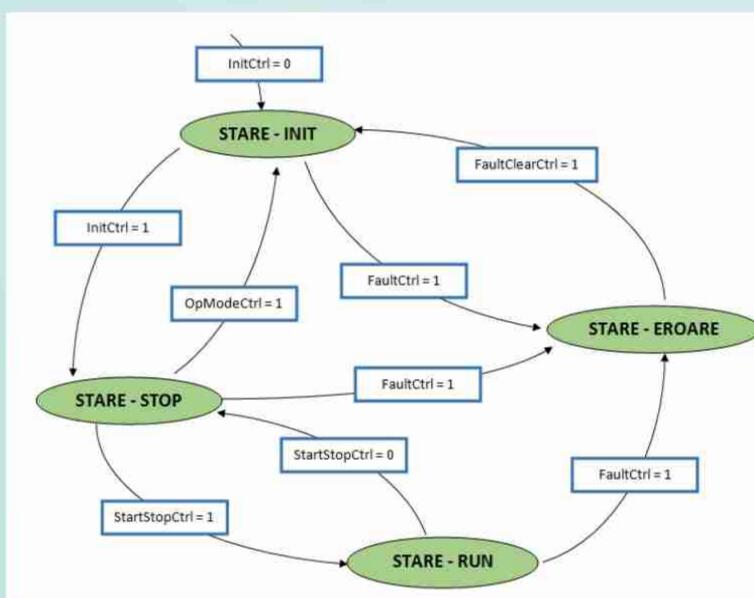
Authors:

VASILE Ionut, SBURLAN Ion-Cătălin, TUDOR Emil, CONSTANTIN Alexandru-Ionel, **DUMITRU** Constantin

Patent application No. A/00254/14.05.2021



Five phase inverter schematic with five phase induction motor load



State diagram for five phase inverter control

#### Abstract

The present invention refers to a static power converter with five phases that supplies a five phase induction motor and the control method used in case a phase fault happens.

#### **Applications**

The range of application this converter covers includes electric traction drives, hoisting equipment, overhead cranes and elevators, electric boats, electric planes and basically, any application where the electric drive is a critical component to the safety operation of the equipment, where a fault can interrupt the operation of the equipment leading to safety hazards for the operators or to negative economic consequences.

### Technical problem

The technical problem this invention solves is the supply of a five phase induction motor in normal operating conditions as well as in the case of a phase fault.

#### Technical solution

In such condition, the control block of the converter will automatically detect the fault and will make the necessary correction to the control signals of the converter so that the motor can still drive the load with reduced power output. This correction is done by changing the phase angles of the voltage vectors supplied to the motor in order to compensate the missing faulty phase.

### Main characteristics

Five phase inverter

- IGBT transistors technology,
- LEM high precision voltage sensor,
- CSNR current sensor,
- 24 Vdc to +5/+15/-15 Vdc supply,
- Semikron drivers with fault protection,
- PDB-01 motherboard,

ARM Cortex M3 processor.

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Code C: ELECTRONICS | ELECTRICITY



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## Proportional Solenoid Valve with Electronic Control

Patent application no. A/00476/29-08-2023

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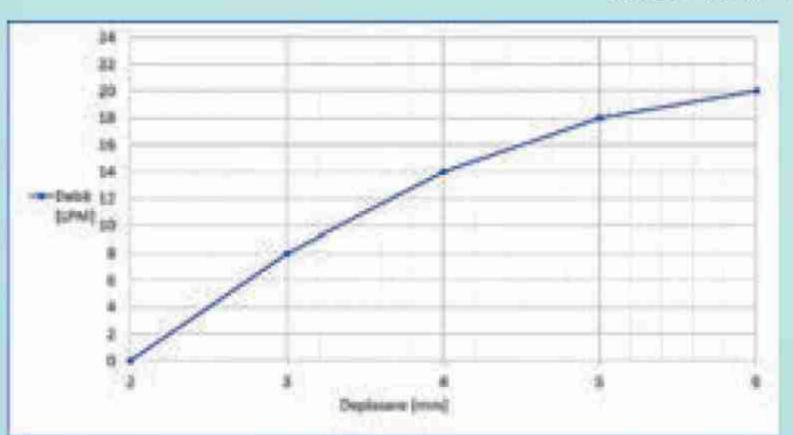
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Section through the proportional solenoid valve with electronic control

- Novelty/Description: The patent application consists of the realization of a proportional solenoid valve with electronic control. This is made up of:
- a linear proportional electromagnetic actuator assembly formed by a mobile core that moves linearly in the electromagnetic field generated by a coil;
- an electronic control module assembly that provides Pulse Width Modulation (PWM) type control voltages for powering the coil. The displacement of the moving component of the linear proportional electromagnetic actuator depends only on the ratio between the pulse duration and the PWM voltage period, i.e. the duty cycle, for a fixed frequency of the PWM control voltage, of 24 kHz, and the set peak-topeak amplitude of the applied voltage of 24 V.
- a hydraulic assembly of the proportional solenoid valve with electronic control, which includes a piston that moves in the hydraulic cylinder under the influence of the electromagnetic force generated by the linear proportional electromagnetic actuator and the opposite elastic force from a spring. The overlapping of the piston channels with the circular channel of the cylinder creates two openings of variable section, the fluid flow rate increasing directly proportional to the displacement of the hydraulic assembly piston in the range of 2 - 6 mm, at 20 bar inlet pressure.

## Advantages:

- Simple and robust design of the proportional solenoid valve with electronic control hydraulic assembly that performs flow control, so that the working fluid exerts only radial forces on the piston, ensuring a perfect balance of forces and eliminating opposition to the piston movement. In this way, the risk of wear is reduced and an increase in durability is achieved;
- The proportional solenoid valve with electronic control has a linear flow characteristic depending on the displacement of the hydraulic assembly piston;
- Fast response time of the proportional solenoid valve with electronic control, due to the movable magnetic core and the fixed magnetic core, of truncated conical shape, as well as the supply of the coil with voltage in the form of Pulse Width Modulation;
- The electronic control module is integrated into the construction of the proportional solenoid valve with electronic control.



Flow characteristic as a function of piston displacement, at inlet pressure of 20 bar

## Applications in the fields of:

- in the aerospace industry, in flight control systems, as it can control the fluid in hydraulic systems that actuate control surfaces such as ailerons, flaps, spoilers, elevator, rudder and trim tabs;
- in the defense industry, as it can control the flow of fuel and oxidizer in rocket engines, which is essential for their guidance and control;
- for hydraulic systems that control rudders and other steering mechanisms on ships;
- in drinking water treatment plants, for precise control of chemicals and water flow in treatment processes.



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## Nanocomposites Based on Polyurethane Foam/Silver Nanoparticles and Process for Their Production

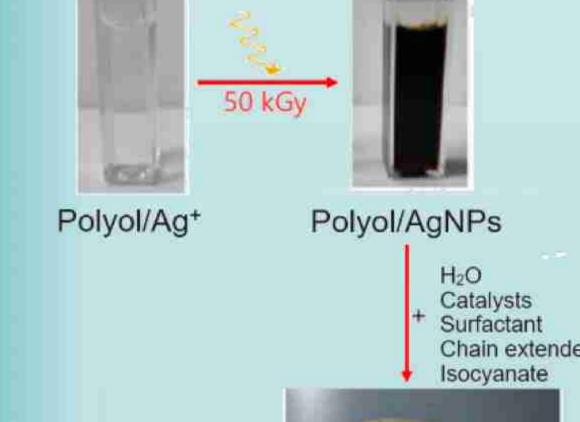
Patent Application No. A/00662/11.10.2022

Authors: Lungulescu<sup>1</sup> E.M., Nicula<sup>1</sup> N.O, Setnescu<sup>1</sup> R., Ion<sup>1</sup> I., Marinescu<sup>1</sup> V.E., Fierascu<sup>2</sup> R.C., Stan<sup>3</sup> M.S.

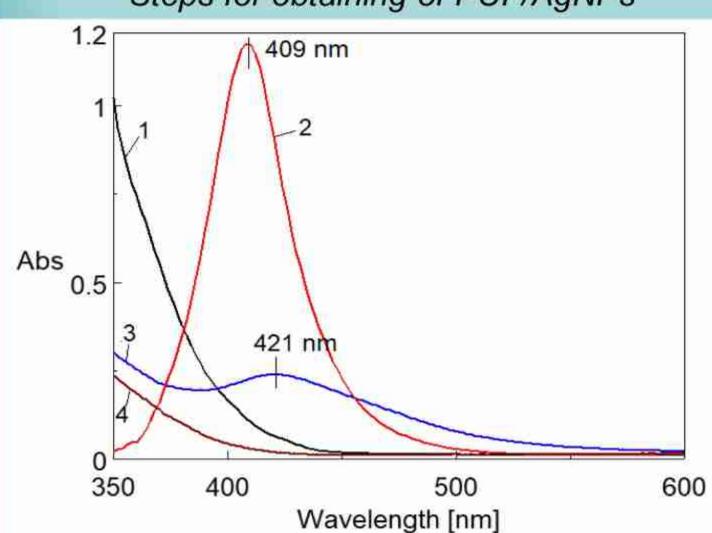
<sup>1</sup> INCDIE ICPE-CA Bucharest; <sup>2</sup> ICECHIM Bucharest; <sup>3</sup> University of Bucharest, Faculty of Biology

#### **Novelty/ Description**

The invention relates to nanocomposites based on polyurethane foam (PUF) and silver nanoparticles (AgNPs), synthesized in situ with controllable properties (size, narrow size distribution, and high stability) and antimicrobial activity, as well as to the process for their obtaining. According to the invention, polyurethane foam/silver nanoparticle nanocomposites are obtained by γ-radiation exposure of a polyether polyol solution which contains a small amount of water (less than 1.0%), in which a silver ion precursor is dissolved. It may also contain stabilizing agents for the polyol matrix and enhancers for the silver nanoparticle reduction process, such as natural or synthetic antioxidants. Due to its specific chemical structure, the polyether solution exhibits intrinsic resistance to ionizing radiation, ensuring the stabilization of silver nanoparticles.



Steps for obtaining of PUF/AgNPs



UV-Vis Spectra of Polyol/AgNPs and Corresponding Polyurethane Foams Irradiated at 50 kGy: 1 – Without Ag \*; 2 – Polyol/AgNPs; 3 - PUF/AgNPs; 4 - PUF Without Ag \*

#### Advantages:

- The proposed method for obtaining polyurethane foam/silver nanoparticle nanocomposites is simple and fast, can be carried out at ambient pressure and temperature, and requires only a single step.
- The synthesis of polyurethane foam-based nanocomposites involves mixing the irradiated polyol solution/silver nanoparticles with modified isocyanates of the prepolymer type (containing 18-30% NCO), in the presence of blowing agents, catalysts, and surfactants. Irradiating the polyol solution, with a small amount of water containing the silver ion precursor, enables precise control of process parameters (concentration, temperature, dose) at any point in the reactor, ensuring high reproducibility.
- The synthesis process does not require toxic or biologically hazardous reducing agents; the primary reducing agent in the absence of oxygen is the hydrated electron, which has a very high reduction potential.
- The resulting nanocomposites exhibit uniform dispersion and high long-term stability of silver nanoparticles.
- The proposed synthesis process allows for the cost-effective production of large quantities of polyurethane foam/silver nanoparticle nanocomposites with controlled size and structure, making it suitable for industrial-scale applications.
- The average nanoparticle size and size distribution critically depend on a limited number of easily controllable parameters, specifically the irradiation dose and the initial concentration of silver ions.

#### **Applications:**

The in-situ synthesis of silver nanoparticles within polyol presents an innovative approach for polyurethane foam nanocomposites, enabling direct nanoparticle integration without additional stabilizers. The results confirm that PUF/AgNPs are biocompatible, showing no cytotoxicity, membrane damage, or pro-inflammatory effects in HaCaT cells after short-term exposure. Additionally, the uniform nanoparticle distribution enhances mechanical strength and antimicrobial properties, making these nanocomposites promising for biomedical applications, such as hospital bed mattresses, floor mats, and covering materials.



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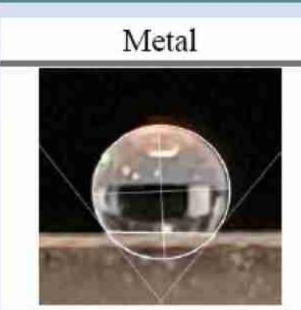
## Superhydrophobic Structures with Self-Cleaning Effect Based on SiO<sub>2</sub> Functionalized with HMDS-type Silane and **Obtaining Process**

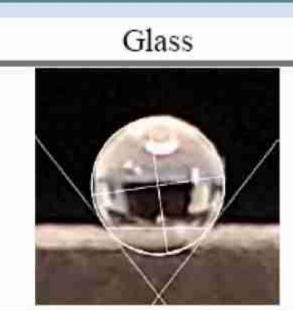
Patent Application No. A 00523/22.09.2023

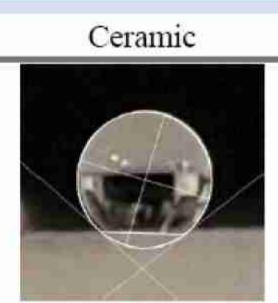
**Authors:** M. M. Codescu<sup>1</sup>, E. Chiţanu<sup>1</sup>, T. Mălăeru<sup>1</sup>, C. A. Banciu<sup>1</sup>, V. E. Marinescu<sup>1</sup>, G. Georgescu<sup>1</sup>, D. Pătroi<sup>1</sup>, I. Borbáth<sup>2</sup>, T. Borbáth<sup>2</sup>, F. T. Boros<sup>2</sup>, C. Bencze<sup>2</sup> <sup>1</sup> National Institute for R&D in Electrical Engineering ICPE-CA Bucharest, Romania <sup>2</sup> SC ROSEAL SA Odorheiu Secuiesc, county Harghita, Romania

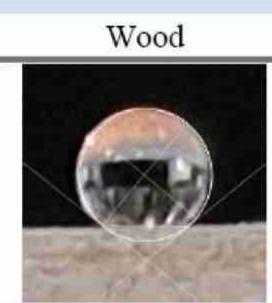
## **Novelty / Description**

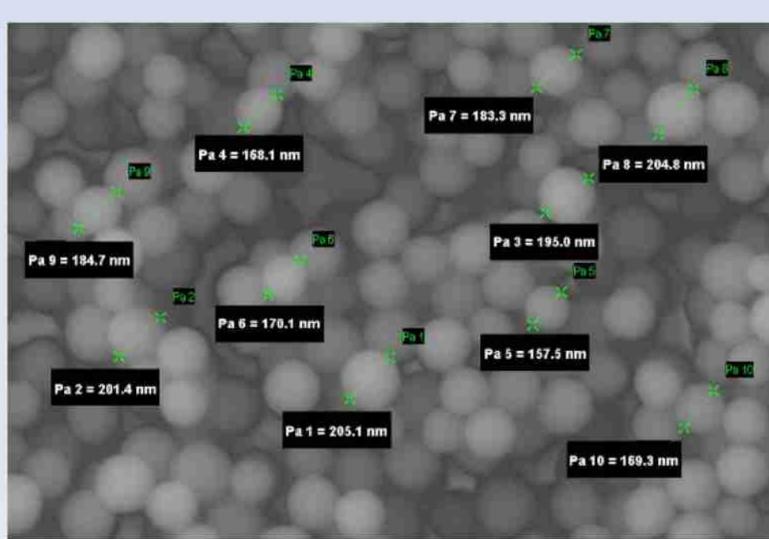
The invention refers to materials with a self-cleaning effect, prepared starting from silica-polymer type materials, which present controllable properties of (super)hydrophobicity and self-cleaning capabilities (water contact angle: 135-167°, drop roll angle: 3-5° and self-cleaning effect, exhibited by entrainment of dirt by water), made by functionalizing the surface of SiO<sub>2</sub> nanoparticles (NPs) with hexamethyldisilazane (HMDS), prepared using the Stöber process, which allows the synthesis of SiO<sub>2</sub> particles with controllable, uniform sizes, and to the process of obtaining them. Materials with (super)hydrophobic behavior are found in applications in bio antifouling paints, transparent coatings for windshield glass, photovoltaic panels, solar cells, stain/water resistant clothing, anti-icing, anti-corrosion coatings.











Contact angle measurements for various coatings based on SiO<sub>2</sub> NPs functionalized with silane

Metal: 130° - 143° Glass: 136° - 141° Ceramic: 143° - 150° Wood: 142° - 143°



## Advantages:

- chemical synthesis of nanopowders with high control of structural and functional properties;
- ensuring the hydrophobic properties by functionalizing with silanes;
- weak water adhesion and self-cleaning behavior;
- possibility of use in coatings for parts with special geometries.

## Applications:

Superhydrophobic structures with self-cleaning effect based on SiO<sub>2</sub> functionalized with HMDS-type silane have applications in the fields of:

- bio anti-fouling paints;
- transparent coatings for windshield glass;
- photovoltaic panels, solar cells; stain/water resistant clothing;
- anti-icing;
- anti-corrosion coatings.

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