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RESEARCH REGARDING DIFFERENT APPLICATIONS OF SILVER IN TEXTILE

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Abstract: *Experimental research presented in this paper are based on septic properties of silver. The experiment creates premises for developing of project concepts, products and inscriptions (applications of graphic signs), ionization treatments with silver ions, which ensures the quality of the septic product in an ecological way (no preservatives and no toxic chemicals), characterised by a modern design. Thus developing concepts of textile products, the development of accessories needed for manufacturing textile products that ensure the property of being septic, development of eco-friendly products without thermochemical treatments, are applications that the designer can achieve based on the properties of silver. The paper presents both technological capabilities and properties of silver to be able to be used in the field of textiles, as well as the creativity of designers to generate ideas for new applications of this material in the field of industrial products in the textile, garments. The importance of the designer's involvement in creating septic and ecological products, which respecst the environment represent the focus of this work. The deformability properties of silver are the inspiration for designer even when it shows major deformities, caused as a result of tests of endurance. Surface modifications of this material can cause identification of applications of this precious metal, turning in esthetic product, scrap, samples, test specimens subjected to various tests.*

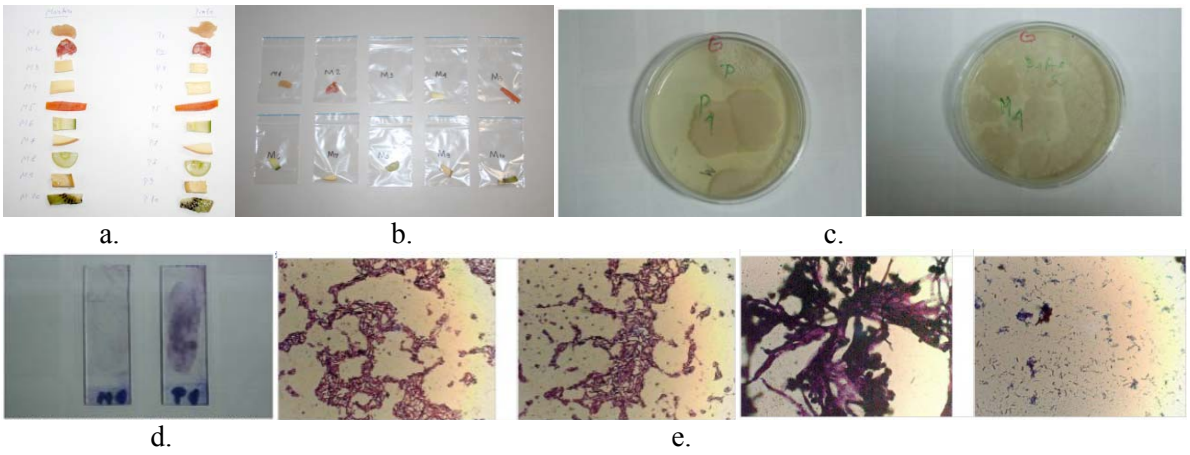
Key words: *design, silver, septic, eclogical, textile product..*

1. INTRODUCTION

The use of silver or silver alloy in textiles and accessories, requires knowledge of the reaction of the metal processing by cold plastic deformation [1]. The textile industry, produces a wide range of textile fabrics in a range of thicknesses, degrees of fineness, composition, structure. Regardless of the type of material you are going to apply to the accessories, they must be safe and the must lasting during use. The attachment must be free of processing traces, which would affect the aesthetics of the product, to be easily mounted and used to provide safty, to be easy but sturdy, and ergonomic. The textile industry in its development requires solutions to provide proper hygienic conditions, safety and comfort, without contaminating the environment. For stopping the process of contamination of the environment, will be undertaken in new procedures and approaches, which are safe and with low toxicity to skin. Metallic ions of silver with bactericide action, are related to "inorganic supports", so that the release of agents in the environment is done gradually, steadily and sustainably. The efficacy of antiseptic qualities of silver ions, have a fast, strong action and are non-toxic and non invesive for environment [2]. The experiments presented in **Fig.1**, has proven that these elements provide the ability to annihilate bacteries. There are two systems of actiona of bactericide:

- Due to the removal of silver ions in water or moist air, the catalytic action of ions takes place by destroying the plasma membrane of bacteria cells, through the potential difference between the external and internal side of the cells.
- Penetration of the silver ions of the plasma membrane of the bacterial cell, destroying the cytoplasm. The use of silver ions from these products is recommended to prevent the transmition of diseases and infections through textile materials. [3]

Silver can be used in textiles industrie or fashion, or in technologies that involves the treatment of fabrics due to its antiseptic properties, as well as in the field of accessories, thanks to its aesthetic and technological properties.



a. b. c.

d. e.

***Fig.1**: Phases of the experiment regarding the influence of silver for preserving food in packages that contain silver elements: a. Food samples, b. Packaging with silver elements and food samples, c. Macromorfological aspect of the colonies developed, d. Coloured microscopic blades, e. Micromorfological aspect of the colony from samples-mycenaean filaments with spores(1000x)[2]*

2. GENERAL INFORMATION

2.1 Silver properties

Fine silver **(Ag999,6 $^{0}/_{00}$)**, precious metal, is used due to its resistance against corrosive agents: in the chemical industry for the manufacture of receptacles; in electro technical industry is used because of its high conductivity, in the manufacture of electrical contacts; in the construction of machines is used due to antifriction properties, particularly in the manufacture of aircraft bearings. Silver alloys are non-ferrous alloys which are obtained on the basis of fine silver. Silver alloys are forming alloys with different metals in the amount imposed for producing the desired alloy, in order to obtain certain properties. Silver alloys keep the essential qualities of metal and the alloying elements contribute to the improvement of some features (e.g., increasing hardness) and changing aesthetic properties (color). Silver-based alloys can be obtained only by alloying with copper, gold, zinc, etc., but do not form alloys with iron (because some metals do not dissolve in the molten state, Ag-Fe being one of them).

The most important physical and mechanical properties, of silver are [4, 5, 6, 7]:

- Reflects the rays of the Moon, is opaque, the reflected light appears white silver;
- The mark made by silver can be white-silver, yellow, grey to black;
- From the contact with air is covered with a dark film, an oxide layer that makes reflects the ageing process, an effect that can be used for aesthetic purposes and that prevents oxidation in depth of silver;
- Polished, has a beautiful glow due to the high power to reflect light;
- The capacity of reflecting in aer is 95,5% for green and is 93% for red;
- The index of refraction is 0,181;
- Is isotropic;
- Silver Hardness is 2.5 (on Mohs scale);
- Specific weight is 10,4923 g/cm3;
- Melting point is 960,50 ° C;
- Boiling point is 21700^{0} C;
- Vaporization temperature 2212^{0}C;
- It is very plastic A_5=48-50 %;
- Is soft (softer than copper and harder than gold) being easily scratched with a sharp object, is light, malleable, ductile, stainless steel;
- Does not combine with oxygen, but it dissolves large amounts of oxygen in the molten state (up to 22 times its volume), which is removed after solidified by throwing metal sprays, which is why silver just can't pour out;
- Presents the highest thermal and electrical conductivity of elements;

- Doesn't clive and often forms angular particles;
- Crystallization system is cubic (4/m³/m 2);
- Rarely presents itself in the form of crystals, often in the form of twisted fibers, dendrites, irregular plates, sometimes curved plates, nuggets, compact masses, foils, etc.;
- When there are crystals they are have the form of dodecaedru; the coefficient of linear expansion is 1.92 x 10-5 at 40□;
- Is diamagnetic;
- Almost all combinations of this metal are non-toxic;
- Allows the passage of light in foil with thickness of min. 0, 003mm;
- From one gram of silver can be obtained a thread length of 2,6 m by pulling it;
- A silver wire with a diameter of 1 mm can support a weight of 16.5 Kg;
- Cristalisation can be of a cubic or octahedron type;
- Separation of silver takes place through: fusion, extraction;
- Can form alloy with Cu, resulting in a light alloy workpiece coloured white (malleable);
- Can form alloy with Hg, resulting in an alloy with a strong glow (in the form of foil results in being the reflective surface of the mirror);
- Can form alloy Ni and Cu, resulting in a alloy used for making coins (by hammering);
- The titles used are: for jewelry $750^0/_{00}$; $800^0/_{00}$; $875^0/_{00}$; $916^0/_{00}$; 925 $^0/_{00}$; for medals and vase $800^0/_{00}$; $900^0/_{00}$; $925^0/_{00}$;
- Nitric Acid affects silver until it is dissolved even in cold condition, and sulfuric acid affects silver in warm state;
- When the silver has a high title ($925^0/_{00}$), and it interacts with a reactive solution of potassium bichromate (saturated solution in nitric acid 45%), it results a precipitate of intense red color called "dove's blood";
- An alloy imitating Ag is mailsort (also known as the silversmith, alpaca), containing 60%Cu +20%Ni +20%Zn or crisocal (Cu alloyed with Zinc);
- Ag is the whitest metal and is distinguished from white gold and platinum by the peculiar brilliance, platinum has bluish shimmer, and gold is slightly greenish white.

Fine silver (according to STAS 3321-93) has the mark Ag 999,6 with a content of 99,96%.

2.2 Silver machinability

Researches in the field of accessories, shows that there are certain preferential technologies used in their processing. Experimental research presented in **Fig.2** and **Fig.3** shows that the processing of silver and silver alloy does not require large deformation forces. The forces required for the processing of silver are lower than those required for silver alloy. Although ductile and malleable, silver and silver alloy are changing they're proprieties due to plastic deformation, requiring the application of heat treatment like annealing and recrystallization. Tools used for the processing the silver accessories must be thoroughly finished because the macro and microgeometrice defects of the tools is printed on the finished part, turning it into the scrap or requiring additional labor to remove these defects. Depending on the piece, it can have a certain finish hardness, imposed by technology, machine, tool, the degree of hardening, and the heat treatment. The major priority for design is for the finishing of the product. The difference between glossy and mate surfaces, the fine lines on the surface, and other effects, (from simple to complex ones), contributes to increasing the aesthetic value of the accessory. Experimental researches carried out on silver, have demonstrated that the designer can use, due to the aesthetic properties of the material, both the finished products and scrap resulting from the manufacturing process of this noble material.

Such pieces and debris resulting from mechanical and technological tests, represents a challenge for the designer in the establishment of ecological benchmarks (reuse, recovery, redesign, rethinking). Thus, attempts to traction, rolling and structural changes and microgeometrics specimens can be exploited through aesthetic and function by the designer. In **Fig.4** are examples of the technological scrap that can be used by the designer for creating accessories, or other applications with septic and decorative purposes.

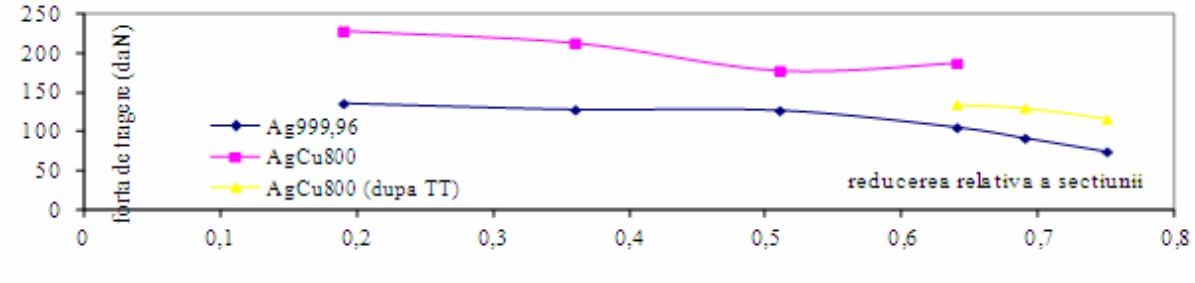


***Fig.2**: The law of variation of wireing process of silver and silver alloy (AgCu800)[4]*

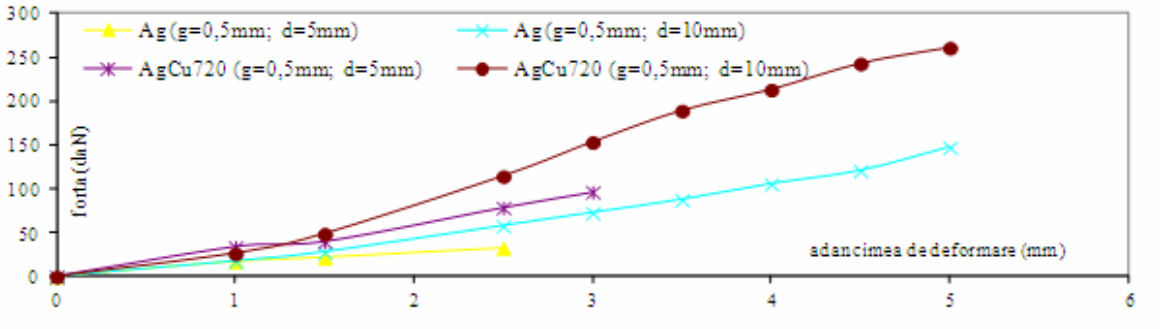


Fig.3: *The strength of distortion at warping silver and silver alloy [4]*

***Fig.4:** Technological silver and silver alloys planks and scrap that can be creatively applied ty the designer to create products with aesthetic value and septic properties*

3. EXPERIMENTAL RESEARCH OF SILVER IN TEXTILE DESIGN

3.1. Experimental data and proposals for accessories

The experiment carried out by using two type samples, packages of different samples of agri-food products with and without silver, showed that silver has a positive effect on the samples used by slowing the processes of dehydration and development of microorganisms cultures. Having inhibitory effect on dehydration, growth and multiplication of micro-organisms, these results allow to develop design concepts for: keeping food, accessories and items of clothing with septic properties, exemplified in **Fig.5.**

***Fig. 5:** Staples and silver buttons, esthetic and functional role, septic*

3.2. Experimental data concerning the application of silver ions on the labeling of textiles

The experiment carried out using silver nitrate concentration of 1%, used as a method of working samples of different materials, different textures, finishes and colors, which have been applied by inserting glyphs using paintbrushes. Being a light sensitive solution, silver nitrate acted differently, **Fig. 6**, on those samples. Coloring the fabric with silver has the purpose to make the material septic helping people with high sensitivity to allergies, and giving the fabric an esthetic design, that can be custom made.

Fig. 6: *Inscriptions made by applying the solution of silver nitrate on different types of textile fabrics, giving them functional, esthetic and septic purposes.*

3.3 Experimental data and proposals for eco-concepts

The technological scrap arising from attempts to wiring, casting, rolling, laminating silver presented in **Fig. 4**, represents a challenge for the designer, in the sense of creating eco-concepts.

Fig. 7: *Decorative applications of silver items resulted from debris and technological samples presented in Fig. 4*

Half-finished products and the technological scrap pieces of silver are a reliable source of generating ideas for accessories that can be used in the fashion design whit the purpose to protect sensitive people against microorganisms and allergies. The use of this scrap pieces shows that silver does not present the "pulling out of use"stage in its life cycle. Being a noble metal it supports unlimited number of cycles in the recovery. In **Fig. 7**, are presented concepts of eco products. These products can be declared as eco because they use creatively materials recovered, recycled or coming through from technological tests (results shown in **Fig. 2, Fig. 3** and **Fig. 4**). The products shown are aesthetic and functional. These ecoconcepts have septic properties due to the use of silver, and they also have a decorative value.

4. CONCLUSIONS

Aesthetic, technological and septic properties of silver can determine the development of design concepts which shows positive impact on human health. Applications of silver are based on its

ability to be recoverable, reusable and nontoxic for the environment. Theoretical and experimental research has led to the following conclusions:

- accessories made of silver can be used for functional, aesthetic and septic purposes;
- use of accessories from silver can have a preventive or curative purpose for people who need a septic environment;
- use of silver ions in embossing and treating of textiles, is an organic, septic method, welcomed in the cases of products made for children or adults with allergy issues or otherwise, and which prevents the use of chemical substances;
- use of silver ions in the labelling of textile products and treatment can be performed by anyone, the application of a layer of silver nitrate, allowing customization of textiles or garments;
- modelling silver does not impose strong deformation forces, which allows its use in creating objects/accessories in a wide variety of shapes, sizes, finishes and alloys (with silver), through a wide range of techniques and technologies (from of manufacturing technologies up to the industrial scale of productivity).

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