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INVESTIGATION ON THE DISTRIBUTION OF COMPONENTS IN RECYCLE DOUBLE BASED PROPELLANTS

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Abstract: *The investigation proposes research on waste recycle double based propellants obtained from utilization, naturally aged in military storage facilities, because the overall effect of these reactions and processes are changes of physical, chemical, thermal, ballistic and mechanical properties with storage time, i.e. the reduction of the propellants performances and safe service life. Double based propellants have a single-channel cylindrical shape. With scanning electron microscopy and EDS microanalysis have been received photos and data on the distribution of the components of the double based propellants.*

Keywords: *double based propellants, utilization, SEM, EDS microanalysis.*

1. INTRODUCTION

For a long time the double base propellants were made by directly mixing dry nitrocellulose (NC) with nitroglycerin (NG). It is extremely dangerous. The propellants mass is unevenly distributed. The swelling processes on the surface of sections of nitrocellulose fibers are important. This makes it difficult for nitroglycerin to penetrate into the depth of nitrocellulose fibers and its uniform distribution throughout the volume. [1,2]

The aim of this study is to investigate the distribution of components in double based propellants obtained from recycling. Samples of the double-base propellant ware dissolved in acetone and pressed twice to obtain a cylindrical shape. They are then stabilized with dibutylphthalate ($C_4H_{22}O_4$), which remains in the same amount after processing (about 1%).

Propellant, known as a kind of energetic materials for launching, usually contains fuel and oxidizer components. It has widespread application in weapon equipment, space navigation, and industrial and agricultural production, so researches on propellant have received great attention for a long time. Double bases propellant usually consists of nitrocellulose (NC) and nitroglycerin (NG), to which a plasticizer is added.

2. RESULTS AND DISCUSSION

The double based propellants, produced in 1985, who are stored in unheated storage facilities in army were tested. After utilization, the propellants were dissolved by a standard method. With the help of rollers, a propellants cloth with a thickness of 5 mm is obtained to remove moisture. The next operation is pressing to obtain single-channel propellants.

Composition of the studied double based propellants (DB) by recipe.

Composition of coloxylin 57,6-59,6%

Nitroglycerin content 39.4-40.6%

The remaining additives up to 100% are stabilizing and technological additives.

We used scanning electron microscopy (SEM) JSM 6390 (Japan) in conjunction with energy dispersive X-ray spectroscopy (EDS, Oxford INCA Energy 350) in regimes of secondary electron image (SEI) and Backscattered Electron contrast (BEC). The accelerating voltage was 20 kV.

The distribution of the elements in wt% was done with the help of EDS detector. Energy-dispersive X-ray spectroscopy is an analytical technique that enables the elemental analysis of materials. A sample excited by an energy source (such as the electron beam of an electron

microscope) dissipates some of the absorbed energy by ejecting a core-shell electron. A higher energy outer-shell electron then proceeds to fill its place, releasing the difference in energy as an X-ray that has a characteristic spectrum based on its atom of origin. This allows for the compositional analysis of a given sample volume that has been excited by the energy source. The position of the peaks in the spectrum identifies the element, whereas the intensity of the signal corresponds to the concentration of the element. We used carbon tape to fix samples and after that we covered with gold, because the samples weren't conductive.

The SEM magnification is x 3000, x 10000 and x 15000, and shown in Fig. 1.

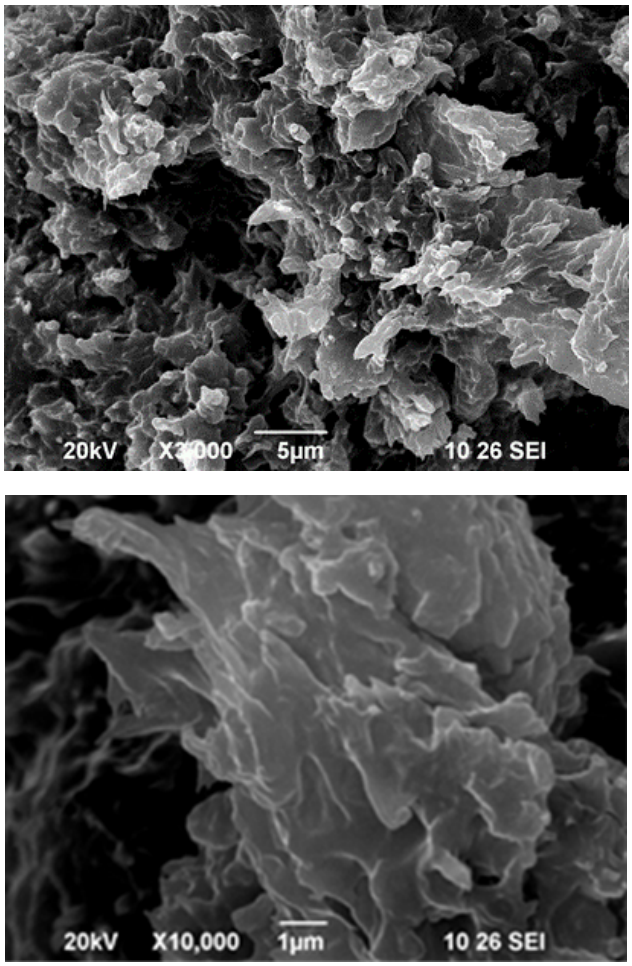

Figure 1. SEM photo of waste double based propellants after secondary processing.

In the Fig.1. are shown smooth and rounded areas, forming aggregates and can be seen the action of destruction in one hand and the action of hydrolysis on the other. It may be assumed that a process of denitration of the nitrocellulose from the propellants takes place, by a process of dissociation. Therefore, structures of hydrolytic origin are obtained [3,4].

The crystalline areas are in the form of lamellae, representing dendrites are visible. The formations are 1.61 by 1.04 µm and illustrate the crystal structure of nitrocellulose from propellants. This is probably due to the higher degree of inhomogeneous nitration and the molecular-structural heterogeneity of nitrocellulose with nitroglycerin. In addition, it is possible to influence the degree of crystallinity of the cellulose from which the nitrocellulose was obtained, because it is also a non-constant value, Fig.2. [5]

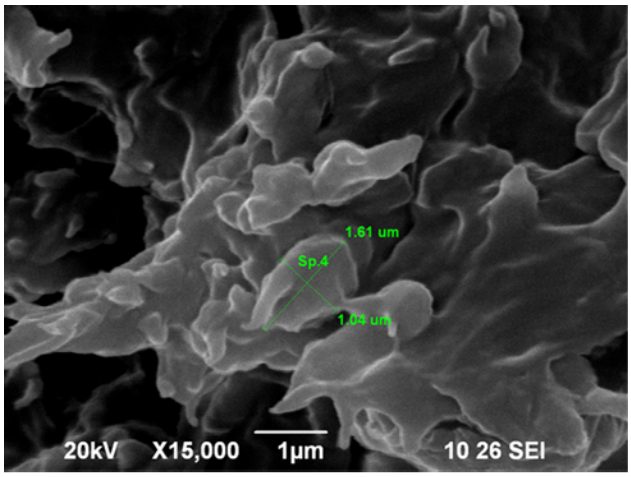

Figure 2. The dimensions of crystal

The double based propellants were done in four points and the results are shown in Table 1 and point 4 is given in Fig. 3.

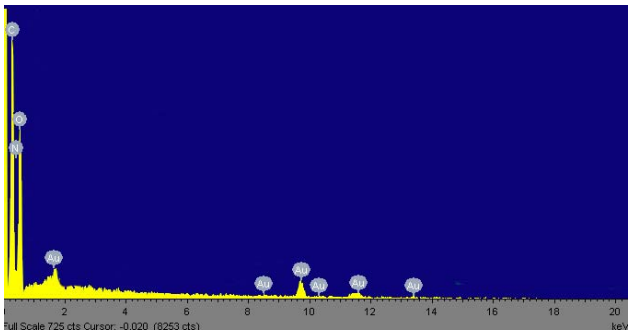

Figure 3. EDS microanalysis of the content of the major elements, in point four.

Table 1. Obtained results for C, N, O content at four points of the double based propellants

wt %	C	N	O	Total
Sp 1	36.72	14.33	48.95	100
Sp 2	26.31	10.35	65.35	100
Sp 3	50.71	0	49.29	100
Sp 4	41.61	19.85	38.54	100

In Table 1 is showing an uneven distribution of the C, N, O content. Even in point three, the nitrogen is absent. This is probably the result of the ongoing destruction processes in the double based propellants during long-term storage. As expected, the molecular weight of nitrocellulose decreases with increasing years of storage. These processes lead to an increase in the OH content, both from the hydrolyzed nitro groups and as end groups when the ether bond between the glycosidic rings is broken. [6,7]

3. CONCLUSIONS

Various processes take place in a double based rocket, propellants grain over time, even under ambient storage conditions. The overall effect of these reactions and processes are changes of physical, chemical, thermal, ballistic and mechanical properties of rocket propellants with storage time, i.e. the reduction of the propellants performances and safe service life. A greater homogenization of the propellant mass is required for the disposal of waste double based propellants than for the production of a new propellant. For the production process is necessary greater control and monitoring.

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