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PROGNOSTICATION THE TERM OF EXPLOITATION OF WORKINGS ELEMENTS OF CUTTERS AND GRINDING DOWNER AFTER IT FINISH PVD WITH THE USED OF METHOD OF ATOMIC FORCE MICROSCOPY

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Аннотация. *В работе приведены результаты исследований и анализа микрогеометрии поверхностей куттеров и гомогенизаторов, со сформированными на них плазменным напылением износостойкими покрытиями, в процессе их эксплуатации с использованием метода атомно-силовой микроскопии, а также приведена методика прогнозирования срока безотказной эксплуатации этих поверхностей.*

Анотація. *В роботі наведені результати досліджень та аналізу мікрогеометрії поверхонь куттерів та гомогенізаторів, зі сформованими на них плазмовим напиленням зносостійкими покриттями, в процесі їхньої експлуатації із застосуванням методу атомно-силової мікроскопії, а також наведена методика прогнозування терміну безвідмовної експлуатації цих поверхонь.*

The increase of the productivity of food equipment, and also qualities of the food products made on it, presents one of basic tasks in food retail industry and it is impossible without the further improvement of operating properties of workings elements (cutters, grindings down etc.) of its equipment. One of effective methods of increase of the productivity and wearproofness of its elements is work-hardening of it superficial layer, for example, through it's retrofitting coverages of TiN_x by the method of PVD.

It is known [1] that by basic indexes which influence on the productivity and reliability of exploitation of workings elements of food equipment, modified TiN_x the method of PVD are remaining microrelief and homogeneity of its surfaces, which must not exceed 250 nm and absence on its of microflaws.

Among the modern methods of research microgeometrical parameters of surface perspective is a method of AFM [2], which is express, précising and its a spatial discriminability about 0,2…0,5 nm.

Therefore, **the purpose of this work** is a leadthrough of researches and analysis microgeometries of surfaces of workings elements of food equipment after PVD by the method of atomic force microscopy for determination hidden microdefects and microrelief of surfaces of these elements during their exploitation, and also prognostications of term of their faultless exploitation.

Method of experiment. Research objects were standards intagliated from the cuttings edges of knives of cutters and valves of grindings down in form cylinders by a diameter 3…5 mm and in 8…10 mm high from steel of X18H10T, which parted on two groups: 1) objects without coverage of TiN; 2) objects which had a layer of TiN (up to 30 mkm) besieged the method of TiN.

Researches microgeometries of surfaces of the probed objects from both groups were conducted on the device of «NT-206V» (manufacturer: Ltd. «Microtestmashine», Bielorussia) with the use of silicic probes of «Ultrasharp CSC12» (manufacturer: «Mikromasch», Germany). Thus, for the increase of authenticity of results, researches were conducted on 9 areas of ground of 13×13 mkm on a surface each of standards. The choice of necessary area on-the-spot standard

was carried out the system microkeepings and built-in optical longfocusing microscope of Logitech (manufacturer: «Logitech Inc», USA).

Researches of objects were conducted as follows. Conducting the ultrasonic cleaning of research object in an ethyl spirit, he was based on a magnetic objective table. Application built-in long-focusing microscope and system microallows keepings with exactness ±2,5 mkm to determine the area of standard the surface of which was probed. As a worker the static mode of operations of AFM was chosen, which possesses less exactness as compared to the dynamic mode, however allows to probe the surface of object, ignoring a presence on it moisture and tailings of organic matters (alcohol, fat acids and etc).

For the increase of exactness and producibility of research results, measurings were conducted on 5…6 standards from every group.

After completion of measuring process, by the system microkeepings the move of measuring head is carried out on a next area.

The results of measurings were added to memory of the personal computer, which enters in the complement of diagnostic complex of atomic force microscope for further visualization, research and analysis.

On fig.1 the results of research of standards are resulted without (a) and with coverage of TiN (b), by the got method of PVD of cuttings edges of knives of cutters and valves of grindings down after it exploitation during 800 hours.

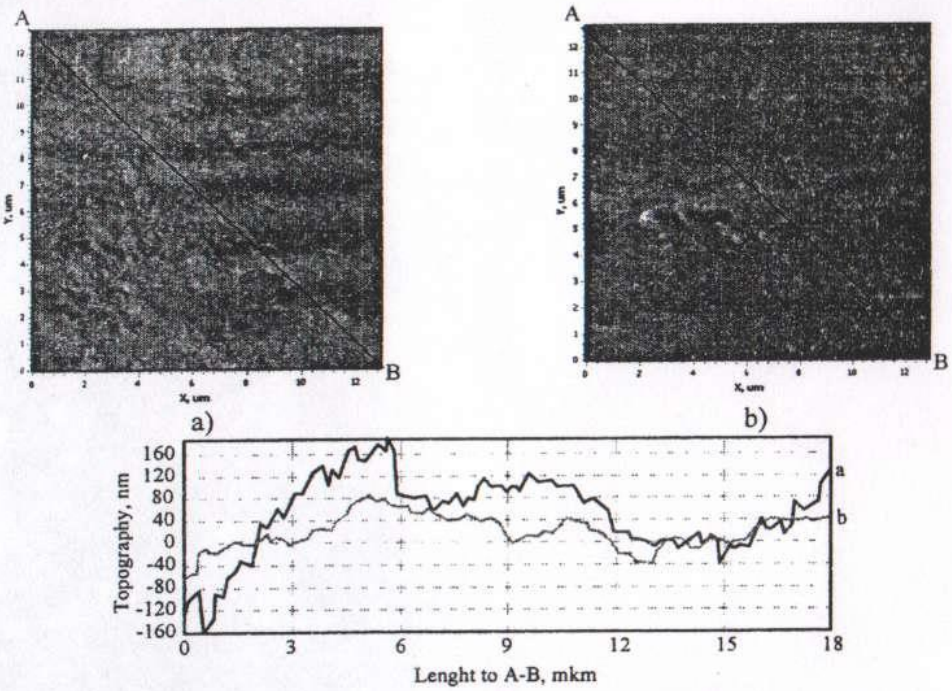

Fig.1. Topogram (1) and profilogram (2) along the line of A-B of area of surface (13×13 mkm) of standard without (a) and with coverage of TiN (b), got method of PVD. NT-206

The analysis of results of AFM of researches of surfaces of initial standards (fig.1.a) allowed to set that in the process of the protracted exploitation there is destruction of its surfaces (increase microburries from 60...90 nm to 280.350 nm, appearance microcracks, splitting off et al microdefects), which results in the fall-off of functional properties of its coverages and productivity of good on the whole. In also time, on standards with coverage of TiN, not observed the besieged method of PVD microdefects, and microburries for the same time of exploitation (800 hours) were increased with 50...60 nm to 85…130 nm. Adgesion properties of coverages of

TiN, inflicted on the optimum mode on setting of HHB-6,6 И1 probed by the method of maring. It is exposed as a result of its researches, that the critical loading at which first crash and removing a layer by the layer of coverage appeared from TiN was 35…65 N, that corresponds the critical shock loading during exploitation of elements of cuttings cutters in 10 N/mm^2.

Mathematical analysis of results of experiment. The analysis of data, got the method of atomic force microscopy, was conducted a planning method two factor experiment, where as entrance variables got out increase of values remaining microburries (%) and amount microdefects on-the-spot standard in the process of his wear at the shock loading 10 N/mm^2, that corresponds the critical loading on this fragment of working element of cutters. Time of wear of standard got out as a response (clock).

The result of planning of experiment was presented as equalization of regression: $Y = 1328 - 0{,}71X_1 - 63X_2$, where Y - a response is time of wear of standard (clock); X_1 is an increase of values remaining microburries (nm); X_2 is an amount microdefects. Comparison of results of calculation on a linearing model with experimental information rotined that the relative error of e determination of time of faultless exploitation did not exceed 8%.

Discussion of the results of experiment. Conducting mathematical treatment of results of experiment and putting in equalization of regression the maximal increase of values remaining microburries (300 nm) on condition of absence microdefects of surface, will get, that the forecast term of exploitation of workings elements of food equipment on the example of fragments of cutters without coverage of TiN makes 800 hours (4,5 month of exploitation), then, as with coverage of TiN, by the besieged method of PVD at the shock critical loading 10 N/mm^2 makes 1200 hours (6,8 months of exploitation).

Conclusions:

1. The analysis of surfaces of initial standards rotined that in the process of the protracted exploitation there is its destruction (increase microburries from 60...90 nm to 280…350 nm, appearance microcracks, splitting off et al microdefects) which results in the fall-off of functional properties of these coverages and productivity of good on the whole. Thus, on standards with coverage of TiN, by the besieged method of PVD microdefects are not observed, and microburries for the same time of exploitation (800 hours) were increased with 50...60 nm to 85...130 nm.

2. As a result thkclerometric researches it is set that the critical loading at which first crash and removing a layer by the layer of coverage appeared from TiN was 35...65 N, that corresponds the critical shock loading during exploitation of elements of cuttings cutters in 10 N/mm^2.

3. Application of method of planning of experiments on results research of workings elements of food equipment on the example of quickly worn down details of cutters and grindings down without and with coverage of TiN allowed to set the forecast term of its exploitation: without coverage - 800 hours (4,5 month of exploitation), with coverage - 1200 hours (6,8 months of exploitation).

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ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ У ПРИЛАДОБУДУВАННІ