The method of determining static microhardness of metals and their alloys by Kotrechko

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Abstract
The developed method of determination of static microhardness of metals and their alloys with use of the indenter of new construction in the form of tetrahedral pyramid with angles between edges $\alpha = 90^0$. It provides change from elastic to plastic deformations in case of smaller values of hardening in the course of tests. The metals microhardness index obtained in case of researches with the suggested method is more accurate in comparison with existing standard ones by Knoop and Vickers. Its application can be recommended to plant and engineering departments of machine-building industry in case of researches of mechanical properties of metals. Novelty of method of static microhardness determination of metals and their alloys is confirmed with patents of Ukraine.
Key words: METAL, STATIC MICROHARDNESS, INDENTER, TETRAHEDRAL PYRAMID, ANGLE BETWEEN PYRAMID EDGES $\alpha = 90^0$

1. **State-of-the-art**

Microhardness of surface layers of metal products after chemical heat treatment, laser and plasma cladding, metallizing, hardening, etc. is connected to their wear resistance, fatigue resistance, and also reliability and longevity of operation of finished products. Therefore, for the purpose of comparative evaluation of specific strengthening types of processing of metals and their alloys, development of new methods of determination of accurate values of microhardness is reasonable.

2. Analysis of the known methods of determina-

tion of static microhardness of metals and their alloys

Methods of determination of metals static microhardness by Knoop and Vickers are known. The first suggested and the most widespread method of determination of microhardness by Knoop [1] was developed by National Bureau of Standards (USA) in 1939. According to this method, during researches rhombic-pyramidal indenter with angles between edges $172^{\circ}30'$ and $\frac{h}{d}=\frac{1}{30}$ is used. Disadvantage of Knoop method is that the ratio of depth of indent (h) to the length of big diagonal (d) is approximately $\frac{h}{d}=\frac{1}{30}$; therefore, in most cases indents are not always symmetric and errors are possible in case of their measurement. The existing standard method of determination of metals microhardness by Vickers [2] assumes regular tetrahedral pyramid with an angle between opposite edges in case of vertex $\alpha=136^{\circ}$ to be used during researches. It is known that impressions of the indenter in metal is followed by its hardening [3]. At the same time, resistance to indenter penetration into sample is constant and depends on its geometry, and the obtained values of hardness exceed actual ones. Therefore, development of new construction of the indenter, which provides transition from elastic to plastic deformations in case of smaller values of hardening, is necessary.

3. Method of determination of static microhardness of metals and their alloys.

For determination of static hardness of metals construction of the indenter [4] in the form of the regular tetrahedral pyramid with vertex angle $\alpha=90^{0}$ is developed and suggested (Figure 1).

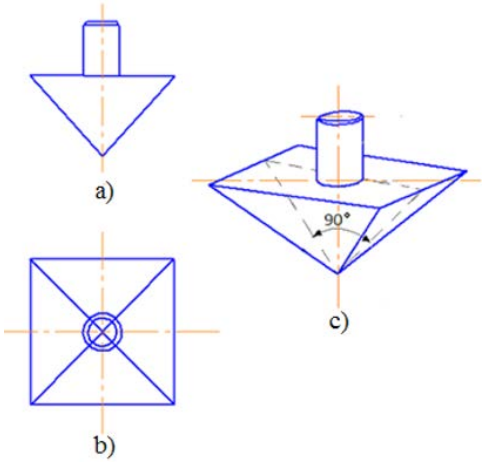

Figure 1. Design of indenter: a) and b) - frontal and horizontal projections respectively; c) - general view

The method of calculation of static microhardness of metals [5] is based on measurement of arithmetic mean values of two diagonals (d_1 and d_2) of indent 1 of pyramid 2 in the researched product 3, obtained after impression of pyramid into a sample (Figure 2).

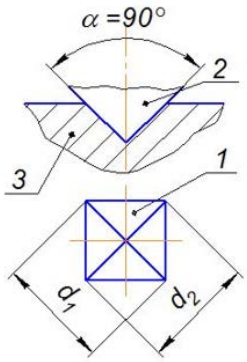

Figure 2. Diagram of measurement of pyramid indent

Value of static microhardness ($HK\mu$) is determined by ratio of loading (P) to the area of indent (F) of a pyramid:

$$HK_{\mu}=\frac{P}{F}, \quad kH/mm^2$$

The area of obtained indent is calculated by formula:

$$F==\frac{d^2}{2sin\frac{\alpha}{2}}=\frac{d^2}{1,4142}, \quad mm^2$$

where d - arithmetic mean value of lengths of two diagonals of indent of pyramid, mm; α – angle between opposite edges at pyramid vertex; $\alpha=90^{0}$.

Consequently, static microhardness will be equal to:

$$HK_{\mu}=1,4142\frac{P}{d^2}, \quad kH/mm^2$$

Conclusions

The use of suggested design of indenter reduces value of hardening during its impression into metal; therefore, values of static microhardness obtained by method of Kotrechko are more accurate than standard ones by Knoop and Vickers. For the purpose of development of the optimum sizes and geometry of finished products and support of their reliability and longevity, application of the developed method of determination of static microhardness of metals during researches of mechanical properties of metals is reasonable; and it can be recommended to plant and engineering departments of machine-building industry in case of researches of mechanical properties of metal products.

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Formation of soil pollution area by oil when there is break of airtightness of main pipeline

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