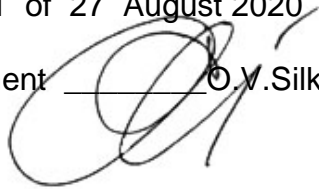


Ministry of Health of Ukraine
Ukrainian Medical Stomatological Academy

It is approved
on meeting of department of
medical informatics, medical and biological physics
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Head of department  O.V. Silkova

Methodical instructions

for students' self-preparation work at preparation for a practical lesson
at home and at the classroom

Subject matter	Medical and biological physics
The unit	1. Fundamentals of higher mathematics and biological physics
Theme of lecture:	Determination of microhardness of dental materials.
Year	1
Faculty	Stomatological
Speciality	Stomatology

Poltava - 2020

The topic significance:

The materiology is integrally interlinked to stomatology and is its integral part. The special value has knowledge of physicommechanical properties of stomatologic materials which allows it's most effective use. Hardness as one of mechanical properties. It should be taken into account, for example, at manufacturing manifold constructions which should work in an oral cavity. It is bound first of all by that hardness of these materials should be approximately equal to hardness of enamel of dens, otherwise at excessive magnification of a material hardness over enamel hardness excessive fracture of enamel will be observed. As hardness of a material term its ability to show resistance to penetration into it of more hard material.

The aims of the training course:

To have general knowledge of the topic studied, aims and tasks of stomatologic materials studies;

To understand methods of hardness definition, to remember and to use the knowledge received;

To familiarize with operation of the **hardness gauge** (device for measuring hardness) ПМТ-3;

To familiarize with method of the sample preparation;

To master skill of hardness measure by Vickers's method and to expect quantity of hardness on quantity of impress.

To take possession of work skills with devices for measurement of these parameters;

To be able to carry out laboratory and experimental work.

3. Materials for the before – class work self – preparation work:

3.1 Basic knowledge, experience, skills necessary for studying the topic in connection with other subjects:

Science	To know	To be able to
basis knowledge of physics	basic concepts of mechanical properties	speak about this topic, to prepare sample to experiment; to measure hardness with using of the hardness gauge ПМТ-3

Practical work executed in class

To master the skills of working with the equipment for hardness measuring.

1. To familiarize with operation of the hardness gauge ПМТ-3.
 2. To familiarize with method of the sample preparation.
 1. Onto the special prism to put plasticine (sand blend).
 2. To put sample onto plasticine.
 3. To press sample by hand-power press to obtain horizontal surface.
 4. Under microscope of hardness gauge to define a place for sample research of microhardness.
 5. To put sample under mechanism.
 6. To make depression on the sample by a diamond tip (pyramid).
 3. To view a sample under microscope of hardness gauge.
 4. To calculate microhardness of stomatological material.
 1. To view microphotography.
 2. To determine scale-division value [scale interval, graduating mark, graduation mark] at microphotography; scale-division value recalculate unto meters.
 3. To measure both diagonals of square by ruler. Take into attention scale on picture!
 4. To write data into a table (in meters).
 5. Test was made at loading 0,3 N.
- To calculate microhardness of stomatological material by formula:
- $$H_v = \frac{1,854F}{d^2}$$
- where F - load, d – average of square diagonals.
5. Determine average value of material microhardness.
 - 1) Calculate average value of microhardness by obtained stamps at specified loadings (repeate items 4.3–4.5).
 - 2) Put an obtained data into a table.
 5. To draw a conclusion.

Table

	F, N	d ₁ , m	d ₂ , m	d, m	H _v , Pa
1.					
2.					

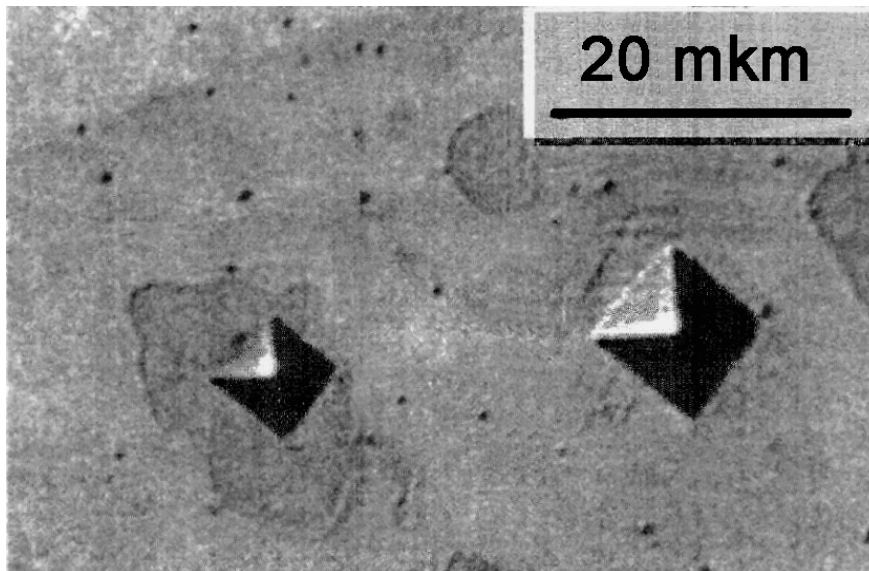


Fig. 2. Two impressions of Vickers indenter in the sample surface at 0,3N pressure.

The contents of the topic:

The materiology (material engineering) is integrally interlinked to stomatology and is its integral part. One of main it's tasks is development of material for tooth stopping, prosthetic devices, medical instruments and support constructions. The special meaning has knowledge of physico-mechanical properties of stomatologic materials which allows the possibility of their most effective use. Durability (strength) as one of mechanical properties should be taken into account, for example, at manufacturing manifold constructions which should work in an oral cavity.

Hardness (as one of mechanical properties) should be taken into account, for example, at manufacturing manifold constructions which should work in an oral cavity. It is bound first at all by that hardness of these materials should be approximately peer to hardness of dens enamel; differently at excess of a material hardness over hardness of teeth enamel excessive fracture of enamel will be observed. As hardness of a material term its ability to put up resistance to penetration of more solid material into it.

Hardness

Hardness is ability of material to resist for hardness indentation (impression, penetration) into it or scratching, that is local plastic deformation. Hardness is measure of cohesion of material atomic structure.

At impression hardness is equal to loading in the ratio to surface of imprint. Sometimes hardness is measured by height of bounce [springback] of small ball.

Hardness (and durability) of material depends on direction of outer force influence.

The meaning of various materials hardness and biological hard tissues hardness measuring is using obtained data for necessary construction prosthetic devices, medical instruments and support constructions. It has in medicine the large practical importance. Task and methods of research of, elasticity, limits of elasticity, hardness and material fatigue are subjects of stomatological material engineering, as influence of temperature and long-term mechanical impact too.

In stomatological practice it is important to practice to know the hardness of dental materials and the hardness of tooth substance, which depends significantly on the age of a man and his diseases.

Hardness determination

Among methods of hardness definition the most prime and visual is method of Moos – comparison of hardness on ten-mark scale of Moos by scratching method (on the sizes of a scratch). According to this scale such unities of hardness set:

Talc	1	Feldspar	6
Rock salt	2	Quartz	7
Limestone spar	3	Topaz	8
Fluor-spar	4	Corundum (emery)	9
Apatite	5	Diamond	10

Moos scale is relative, it don't give us exact quantitative measure of different materials hardness. Interval between diamond and corundum hardness and greatly more than between corundum and talc –softest material in scale – hardness.

Other quantitative methods of hardness determine are anyhow bound to definition of the size of impress (imprint) on a material at penetration into it under activity of dosed effort of the some indenter (rider) - a metal blob (Brinel method), a diamond cone (Rockwell method), a diamond pyramid (Vickers's method, fig.1) and some others.

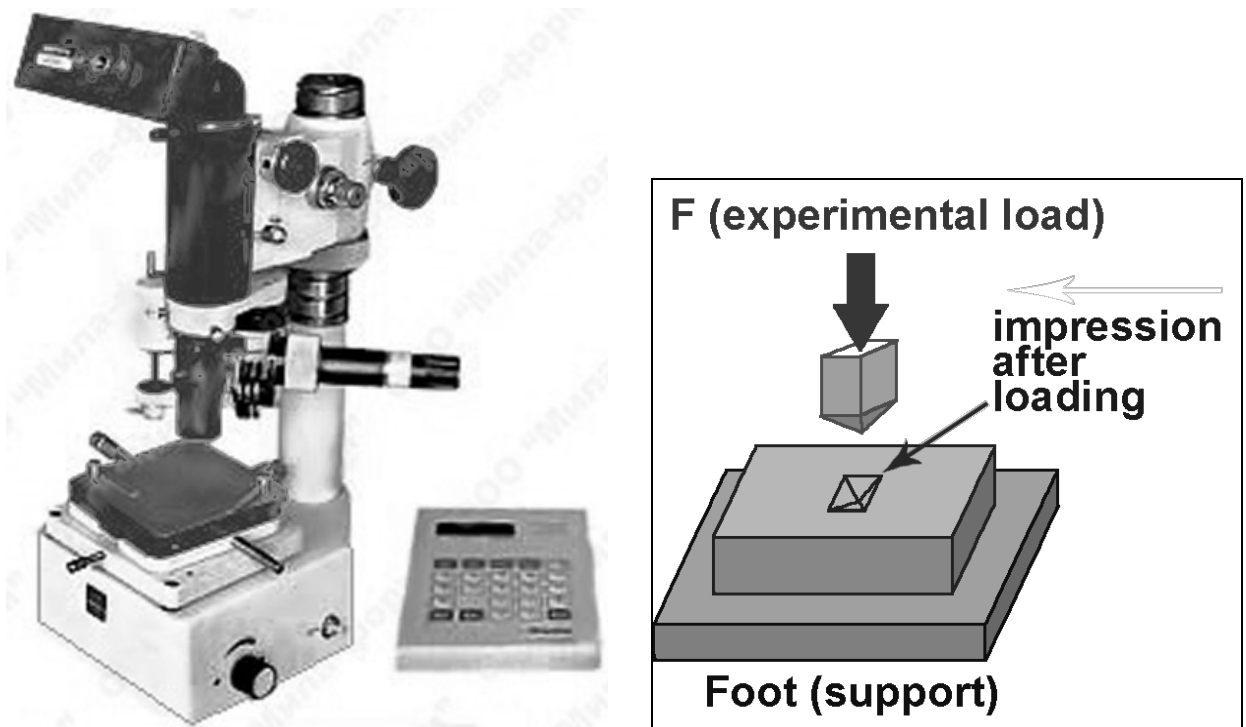


Fig.1. Hardness meter (overview of microhardness meter and scheme of working area).

Microhardness meter ПМТ-3 is device for measurement of microhardness of metal, alloys, glass, abrasive materials, ceramics and minerals bay way of diamond indenter impression.

Diamond indenter is impressed into studied material under specified loading with following measurement of obtained stamp diagonal. Value of microhardness is determined by ratio of loading to the conditional area of side surface of obtained stamp: $H_v = \frac{F}{S}$, where F – normal loading, applied to the indenter, S – average conditional area of side surface of square stamp.

Self-control material:

A. Questions to be answered:

1. What is termed as mechanical characteristics of materials?
2. What are mechanical properties of the materials?
3. What is the elasticity of a material?
4. What is the durability of a material?
5. What is the breaking point of a material?

6. What is the hardness of a material?
7. What physical processes are cause of a certain hardness value?
8. Methods of hardness test.
9. What methods of hardness test are used in stomatology?
10. Principle of operation of hardness meter ПМТ-3.
11. How to measure hardness with hardness meter ПМТ-3 using.
 - B. Test tasks to be done:*
 1. Why mechanical characteristics of stomatologic materials must be close to mechanical characteristics of tooth enamel?
 2. Why scratching method don't use in stomatology?
 3. Why at Vickers's method for the definition of the material hardness demands are made to geometrical parameters of the sample?

Literature recommended

Main sources.

- Chaliy at all., Biological and medical physics. – A.V. Chaliy et all.– Ed.A.V. Chaliy. – Vinnitsia, Nova Knyha. –2013. – 480 pp.
 - L.D.Korovina. Biophysics with beginnings of mathematical analysis and statistics. Extended course of lectures. Vol.1. Bases of mathematical analysis, probability theory and mathematical statistics. Methods of obtaining of the biophysical information. Biomechanics. Second supplemented edition. –Poltava, 2017. –127 p.

Additional sources:

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Methodical elaboration have prepared by senior lecturer, PhD Biol.Sc. Korovina L.D.