Micro- and Nano- Techniques of Controlling Microhardness of Photopolymer Composite Materials for Use in Stomatology

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Abstract – **Methods of investigation into microhardness of photopolymer composite materials used in stomatology are considered. Results of using MHT and NHT methods are compared.**

Keywords – **microhardness, photopolymer materials, MHT, NHT, stomatology.**

I. INTRODUCTION

Main criteria of estimation of operative medical rehabilitation are stability and durability of a filling or a dental inlay made from various photopolymer composite materials. It was detected that the clinical state and durability of direct and indirect restoration depend on many factors including filling material's type, type of connection with dental hard tissues, localization of prepared cavity and the method of its preparation, restoration methods.

One of physical-mechanical properties of photopolymer composite materials used for direct and indirect restoration of dental hard tissues is their microhardness. Different materials have different microhardness. It is defined by the material's wearing capacity and depends on porosity, type of filler particles, ratio of monomer and filler and polymerization.

One of main parameters of these materials is microhardness. Microhardness of dental hard tissues varies with age and the influence of various environmental factors. Any intrusion in this system causes qualitative changes of its parameters. A choice of restoration materials depends on physical-mechanical properties of dental hard tissues. Therefore the chosen photopolymer materials should possess properties that approximate dental properties as much as possible.

II. RESULT AND DISCUSSION

We've carried out an investigation into selection of a technique of controlling microhardness of dental photopolymer composite materials Dipol, Filtek Z 250, Charisma.

Various methods of investigation into microhardness exist nowadays. However during estimation of microhardness of photopolymer composite materials some difficulties may arise due to the fact that these materials are elastic.

With the view of controlling microhardness we chose two techniques: MHT and NHT.

Microhardness of photopolymer composite materials was controlled using a microdurometer produced by CSEM (Swiss Center for Electronics and Microtechnology). The devise allows carrying out continuous measurement at various penetration depths of a Vicker's indentor into material. Furthermore, using the high-performance automated method one can determine hardness and the coefficient of elasticity of certain points in the surface layer of various materials. The microdurometer enabled dynamic measurement of hardness in a microrange as well. The force applied to the indentor and its penetration depth are to be registered immediately during the indentation process. Then, the dependence of the indentor's penetration depth on the applied force is to be represented graphically.

The initial loading applied to the photopolymer composite material being investigated by MHT method was in range 10 milinewtons. The loading has been increasing gradually up to 100 milinewtons. The rate of the indentor's penetration amounted to 200 micrometers.

The measurements results are presented in Fig. 1.

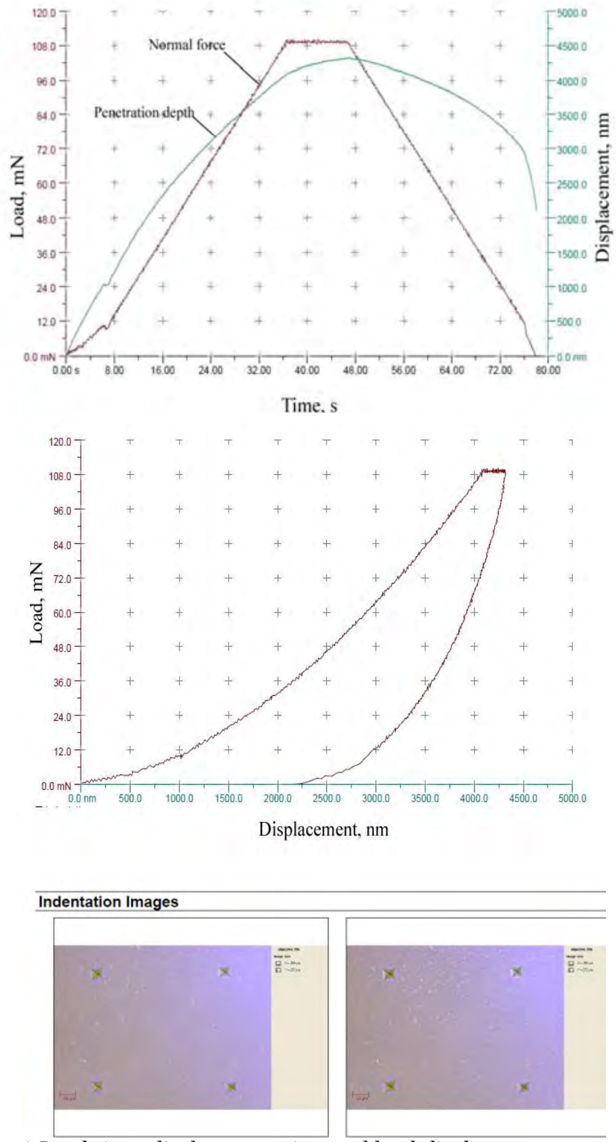

Fig.1 Load-time, displacement-time and load-displacement curves of experimental simples obtained by MHT method

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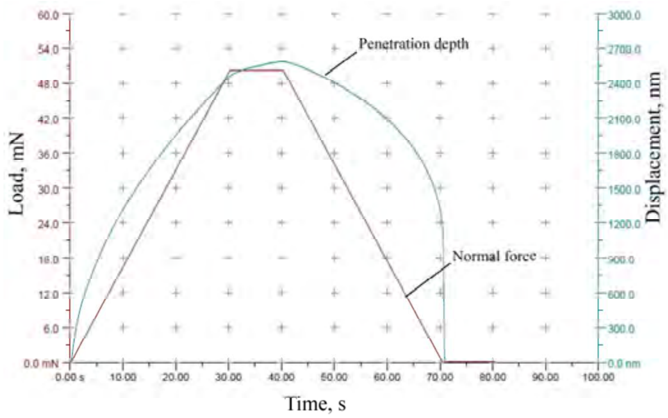
Microhardness was also controlled by NMT method using a nanodurometer produced by CSM Instruments. The nanodurometer provides high nanometric accuracy of the obtained results. The main feature of the nanodurometer is its unique calibration system. The nanoindentor contains a locating ring wrapping the indentor and enabling the regular control of its penetration into the material.

The maximal loading applied to the photopolymer composite material under investigation using NHT method amounted to 100 milinewtons per a minute. The maximal indentor's penetration depth was 200 micrometers.

The measurements results are presented in Fig. 2.

Having compared the obtained results one can state that the NHT methods provide higher accuracy of measurement than MHT.



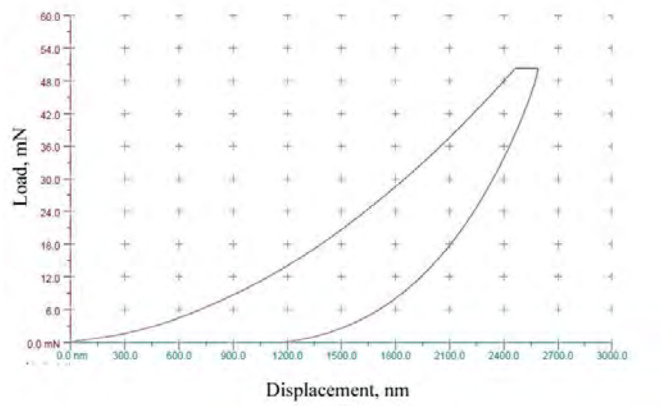


Fig. 2 Load-time, displacement-time and load-displacement curves of experimental simples obtained by NHT method

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