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EXPERIMENTAL RESEARCH ON THE INFLUENCE OF LENS CLEANING PRODUCTS, ON THEIR HARDNESS

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ABSTRACT

The paper presents a study on the influence of optical lens cleaning products for vision correction on their hardness. The lenses under study were previously cleaned repeatedly with different cleaning products, namely, special eyeglass wipes and liquid detergent. The research was carried out on a group of lenses with and without protection, of different thicknesses and diopters.

KEYWORDS: hardness, optical lenses, diopter

1. Introduction

Mechanical and optical properties are important properties in assessing the quality of spectacle lenses intended for vision correction. The quality and maintenance of optical lenses are of particular importance for the efficiency of the vision correction process as well as for their lifespan [1, 3].

The mechanical properties of optical lenses are:

• Hardness: Lens hardness is important for resistance to scratches and abrasions. Glass lenses are harder than plastic lenses and are more scratch resistant.

• Tensile and compressive strength: Lenses must be able to withstand external forces without distorting or cracking. Tensile and compressive strength is important in applications where lenses are subjected to mechanical loads.

• Impact resistance: Impact resistance refers to the ability of lenses to withstand bumps and impacts without breaking or cracking. Plastic lenses are often preferred in applications where impact resistance is important, such as safety glasses and sports applications.

• Resistance to extreme temperatures: Lenses must be able to withstand temperature variations and extreme environmental conditions without changing their optical or mechanical properties. Lens materials, as well as additional treatments applied to their surfaces, can influence resistance to extreme temperatures.

• Chemical resistance: Lenses must be resistant to chemicals and solvents that could damage or corrode their surface. This is especially important in medical and industrial applications where lenses may be exposed to harsh chemicals.

• Moisture resistance: Lenses must withstand moisture and condensation without losing optical clarity or suffering damage. Optical treatments can be applied to improve moisture resistance and prevent condensation on the lens surface.

• Thermal stability: Lenses must retain their optical properties over a wide range of temperatures. Materials used in the manufacture of lenses must be thermally stable to avoid distortion or cracking caused by temperature variations.

• Chemical stability: Lenses must be resistant to chemical attack to maintain their optical clarity in aggressive environments.

• Dimensional stability: It is important that lenses maintain their shape and dimensions under varying conditions of temperature and humidity to ensure adequate optical performance. Materials and manufacturing processes must ensure adequate dimensional stability over time.

2. Experimental research on the influence of maintenance products on lens hardness

Hardness is a physical property of a material that indicates its resistance to permanent deformation or scratching under the action of an external force.

It can be measured by various methods, such as penetration or indentation measurement, and is important in evaluating the quality and performance of materials in a wide range of industrial and engineering applications.

Hardness determination is the process of evaluating a material's resistance to permanent

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deformation, especially breaking or scratching, under the action of an external force [2].

The hardness of optical lenses refers to their resistance to scratches and other forms of mechanical damage. This is an important property for optical lenses, as a scratched or damaged surface can affect image quality and reduce the optical performance of the lens. Factors that influence the quality of optical lenses are:

- Lens material: The hardness of optical lenses is strongly influenced by the material from which they are made. For example, mineral glass such as borosilicate and silicate are known for its hardness and is often used in optical lenses. In comparison, plastic such as polycarbonate is less durable and can be scratched more easily.

- Protective coatings: Some optical lenses are treated with special coatings to protect them from scratches and other forms of damage. Anti-reflective coatings can, in some cases, also offer some protection against scratches. These coatings can affect the hardness of the lens, depending on the material and the technology used to apply them.

- Lens surface: The surface of the lens can also influence its hardness. Lenses with harder or specially treated surfaces may be more resistant to scratches than those with softer surfaces or less protective finishes.

- Care and handling: How optical lenses are cared for and handled can also affect their hardness over time. Using the wrong cleaning solutions or harsh wiping materials can result in scratches and damage to the lens surface [5].

In general, optical lenses are designed to be durable and scratch-resistant under normal conditions of use, but it is important to pay attention to their care and handling to extend their life and maintain image quality.

As part of the research, we determined the hardness of a group of 12 lenses of different thicknesses and diopters, which were cleaned with different maintenance solutions, namely:

- Reference lens with medium protection, diopter -0.50.
- Reference lens without protection, diopter -0.50.
- Lens with medium protection, diopter -0.50, cleaned with detergent.
- Lens with medium protection, diopter -0.50, cleaned with a tissue.
- Lens without protection, diopter -0.50, cleaned with a detergent.
- Lens without protection, diopter -0.50, cleaned with a tissue.
- Reference lens with medium protection, diopter -0.25.
- Reference lens without protection, diopter -0.25.
- Lens with medium protection, diopter -0.25, cleaned with a detergent.
- Lens with medium protection, diopter -0.25, cleaned with a tissue.
- Lens without protection, diopter -0.25, cleaned with a detergent.
- Lens without protection, diopter -0.25, cleaned with tissue.

Hardness determinations were performed on the Micro-Vickers HDT-VS1D INSIZE automatic digital hardness tester (Fig. 1).

Fig. 1. *Micro-Vickers HDT-VS1D INSIZE device*

The technical specifications of the device, are: load 0.5 (kg), replacement time 10 (s), objective at 40x, brightness of 4.

The stages of making the determinations are:

- placing the lens on the device support;
- fixing the specifications used for all determinations;
- focusing the area and marking the length and width;
- data generation by turning on the device. (Fig. 2).

The data obtained after determining the hardness of the lenses, have been centralized in Table 1.

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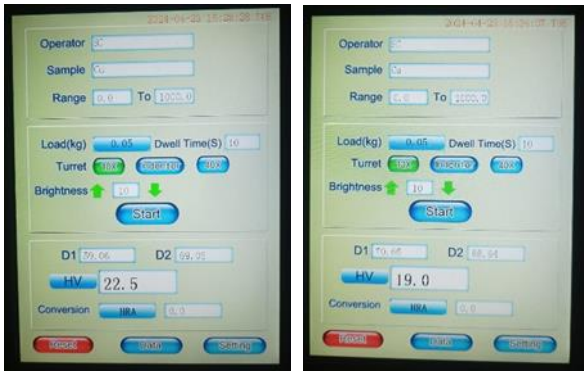

Fig. 2. *Data generation by Micro-Vickers HDT-VS1D INSIZE device*

Table 1. *Hardness of optical lenses*

LENS	D1 (Distance 1)	D2 (Distance 2)	HV (hardness)
Medium protection reference lens -0.50	81.46	79.76	30.2
Reference lens without protection -0.50	79.81	78.64	29.5
Medium protection lens -0.50, cleaned with detergent	64.73	49.13	28.6
Lens with medium protection -0.50, cleaned with tissue	55.59	57.28	29.1
Lens without protection -0.50, cleaned with detergent	67.24	82.65	16.5
Lens without protection -0.50, cleaned with tissue	70.27	66.54	19.8
Medium protection reference lens -0.25	63.52	65.61	25.3
Reference lens without protection -0.25	61.06	70.11	24.96
Medium protection lens -0.25, cleaned with detergent	63.35	63.23	23.1
Lens with medium protection -0.25, cleaned with tissue	61.59	63.40	23.7
Lens without protection -0.25, cleaned with detergent	70.65	68.94	19.0
Lens without protection -0.25, cleaned with tissue	56.06	69.06	22.5

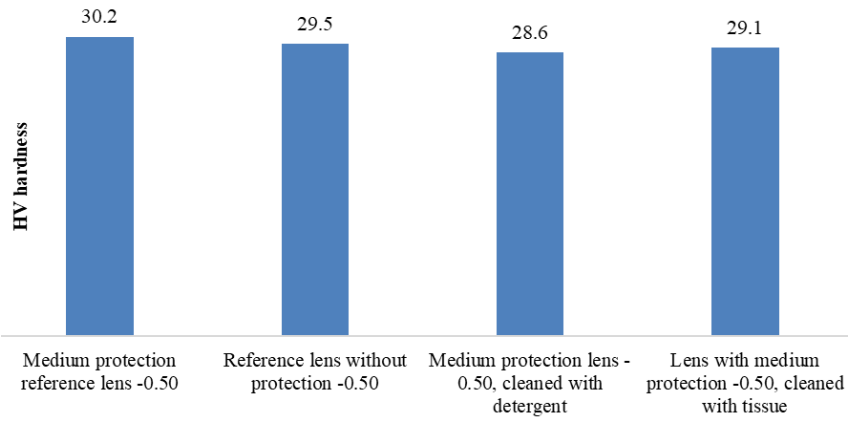

Fig. 3. *Comparing the hardness of the reference lenses*

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For the control lenses, we obtained higher hardness values than for the protective lenses, for both diopters. In terms of lens thickness, we obtained the maximum hardness for the thicker lenses, namely 1.25 mm, for those with -0.50 diopters, compared to 1.17 mm, for those with -0.25 diopters, which means that the lens thickness positively influences the hardness.

For lenses cleaned with a tissue, the maximum hardness was obtained for lenses with protection, with diopter -0.50, and thickness 1.25 mm.

For lenses cleaned with detergent, the hardness is lower than for those cleaned with a tissue. The highest hardness being at the lens with diopters of -0.50, and with a thickness of 1.25 mm.

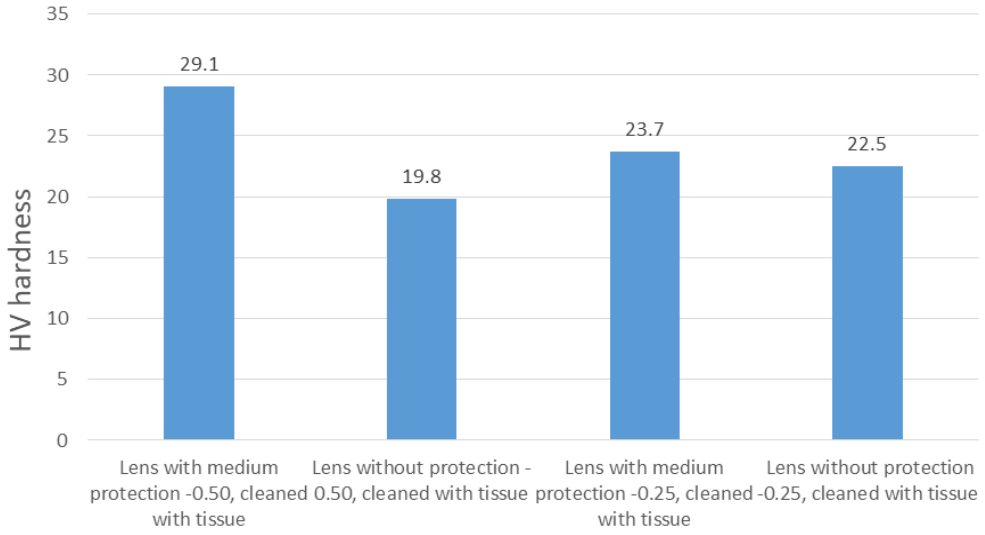

Fig. 4. *Comparison of hardness of lenses, cleaned with eyeglass wipes*

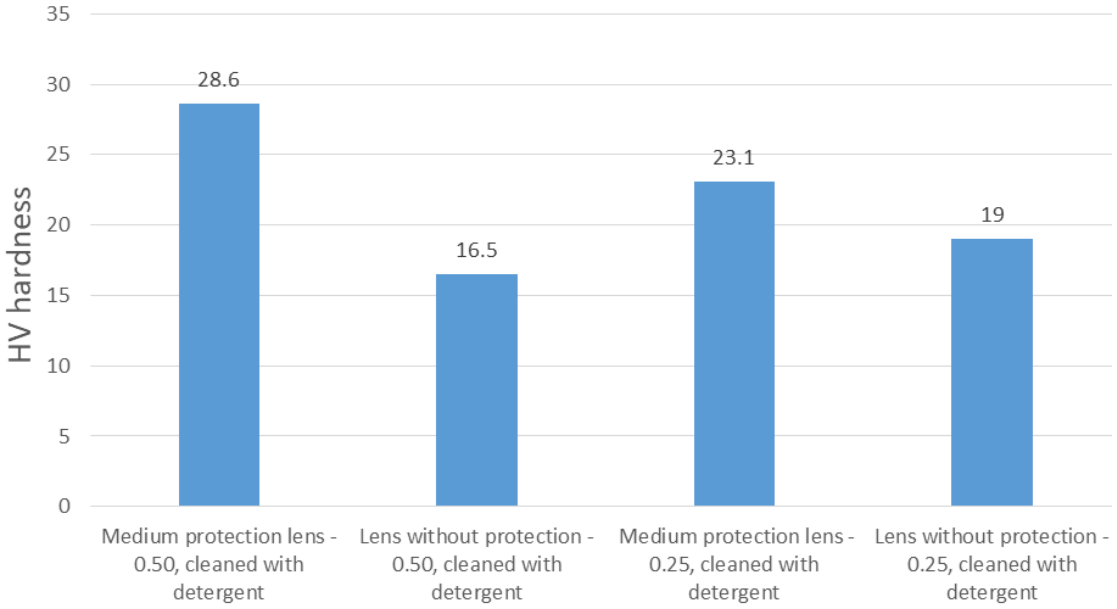

Fig. 5. *Comparison of hardness of lenses cleaned with detergent*

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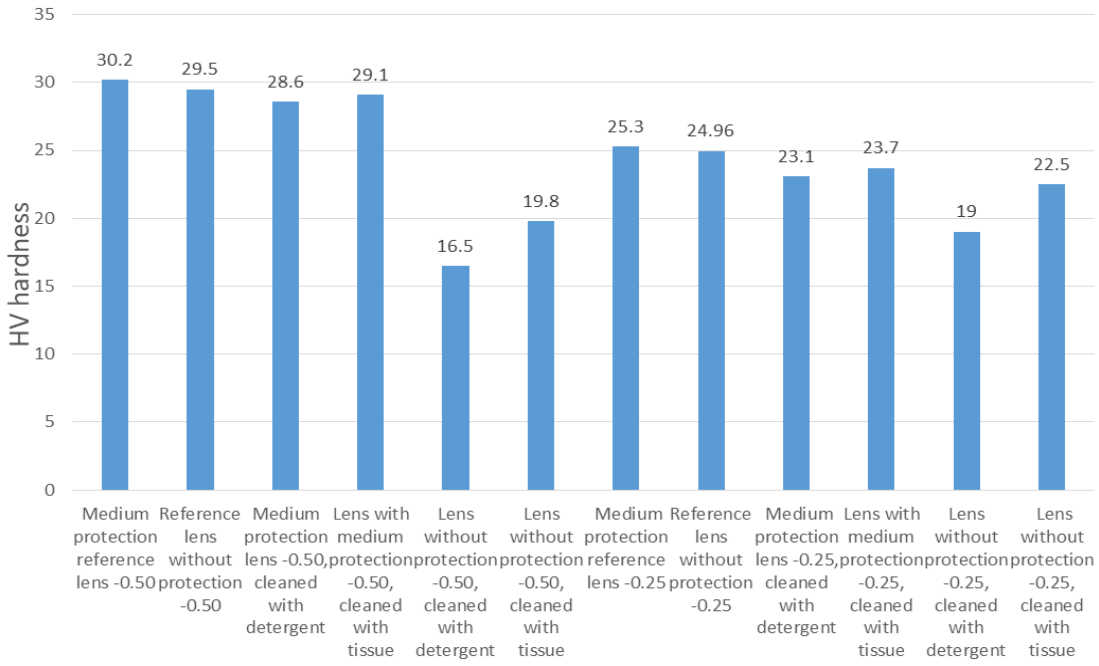

Fig. 6. *Comparison of the hardness of the studied lenses*

Repeated and prolonged application of cleaning solutions leads to a decrease in the hardness of the lens. In lenses cleaned with detergent, the hardness is lower than in those cleaned with a tissue, because the detergent attacks the protective layer more than the tissue.

The determinations were made after the lenses were repeatedly cleaned with special eyeglass cleaning wipes, and repeated washings with dishwashing detergent.

3. Conclusions

Following the data obtained for the hardness of the lenses studied, we concluded that the lenses cleaned with dishwashing detergent have a lower hardness than those cleaned with a wipe, because the chemical composition of the dishwashing detergent damaged the lens surface more deeply than the special wipe.

I noticed that the quality of the lens surface is influenced by the protective layer, regardless of the diopter value. Both for lenses with diopters of -0.50 and those with diopters of -0.25.

The results of this study are essential for improving the quality of lenses and associated maintenance products.

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