THE INFLUENCE OF ADHESION ON THE STATE OF THE SURFACE LAYER OF CONTACT LENSES

Joanna Furgała[1)], Stanisława Szarska[2)], Jerzy Detyna[1)]

[1)] Wroclaw University of Technology, Faculty of Mechanical Engineering, Institute of Materials Science & Applied Mechanics, 50 - 370 Wrocław, Poland

[2)] Wroclaw University of Technology, Faculty of Fundamental Problems of Technology, Institute of Physics, 50 - 370 Wrocław, Poland

Corresponding author: joanna.furgala@pwr.wroc.pl

1. Introduction

Several research focuses on assessing the properties of contact lenses, due to the increasing number of users, whose needs grow because of the conditions in which they work (work at the computer room air-conditioned). The main aspect of providing comfortable wearing contact lenses is their good wettability. Studies on wettability are evolving all the time because of the difficulties to be faced, e.g. incomplete blinking. Hence the search for closest to the natural conditions of the test method,which reflects the reaction of the cornea-contact lens-tear film.

In order to understand the mechanism of interaction between different elements of the system discussed, there need to refer to the fundamental rights of the interactions at the interface between different phases.

Adhesion of a liquid to a solid phase is a physicochemical process, which involves tying up each of these two phases as a result of intermolecular interactions [1].Wettability of the test body depends on the surface tension of the liquid present in the system, and the hydrophilicity of the surface [2,3]. However, mostly used to determine the wettability, is contact angle measurement [1]

The main purpose of this study was to investigate various soft contact lens care solution adhesion to the surface of different types of contact lenses. In addition to standard contact angle measurements using goniometer,a modified method for hydrophilicity measurement of contact lenses, was applied.

2. Modified Method

With respect to interactions on the surface of contact lenses can be derived dependence of the surface tension and energy free surface of the solid (Fig. 1).

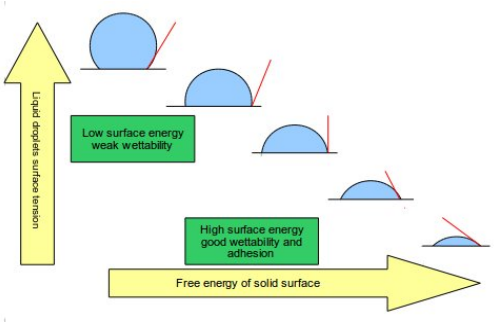

Fig.1: The relationship between surface tension of liquid droplets and the energy free surface of solid

Referring to the above mentioned dependencies, it is possible to determine the surface wettability by setting the contact angle, using a goniometer and the sitting drop method (Fig.2)

Fig. 2: Droplet deposition onto the surface of the contact lens

Determination of contact angle in the sitting drop method involves the use of appropriate trigonometric dependence. Nevertheless due to the interactions between surfaces of different phases (liquid absorption or evaporation), which can result in a change of contact angle over time, other methods are developed.

The method of detachment of solid from the liquid using torsion balance gives an opportunity to study the hydrophilicity of the solid surface. Where hydrophilicity of each material determines its ability to attract water molecules, which in the case of polymeric materials largely depends on their structure [3]. Determination of hydrophilicity is based on measuring the force needed to detach from the surface of the test fluid measurement after the creation of the meniscus. In order to adjust the detachement method for measuring the hydrophilicity of contact lenses, the handle of an appropriate geometry was made (Fig. 3)

a)  b) 

Fig. 3: a) Handle for contact lens, b) torsion balance with mounting handle

3. Research Materials and Measurements

In the present study, contact lenses from different manufacturers was used, with the same optical power and similar geometric parameters. In addition, were tested solutions, which are recommended by the contact lens manufacturers.

Tab.1: Soft contact lenses – characteristic

Type of material	Water content	Buffer	Diameter	Radius of curvature	Producer
Nelfilcon A	69,00%	Buffered saline and 0,05% Poloxamer	14,0	8,7	Ciba Vision
Narafilcon A	46,00%	Buffered sodium chloride solution of methyl cellulose ether	14,2	8,5	Johnson& Johnson
Hilafilcon B	59,00%	Saline solution containing a borate buffer	14,2	8,6	Bausch&Lomb

Characteristics of contact lenses used in the study is presented in table 1, while in table 2 is shown, the characteristics of the two selected and used for research - soft contact lens solutions.

Tab. 2: Soft contact lenses solutions -Parameters

Name of solution	Preservative	Cleaning agent	Moisturizing agent	pH	Osmolality [mOsm/Kg]	Surface tension [mN/m]	Viscosity [cPa]
Solocare® *Aqua*	Poliheksamid 0,0001% EDTA	Poloxamer 407	Aqualube	7,23	310	35,1	1,13
Optifree® *Express*	Polyquad, Aldox	Sodium cytrate	Tetronic	7,82	225	31,2	1,04

To obtain best contact lens adhesion to holder, element with smaller diameter was used. Data acquisition is showned on Figure 4.

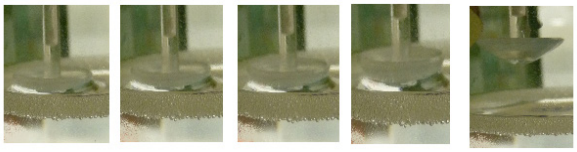

Fig. 4: Contact lens detachment from solution

Prior relevant research, carried out a number of important, preliminary measurements to optimize research methods.

4. Experimental Results

The following submitted Figure 5 illustrates the change contact angle of soft contact lenses, depending on the used soft contact lens care solution. For comparison in the chart, are shown results of the contact angle formed, at the contact lens system with distilled water.

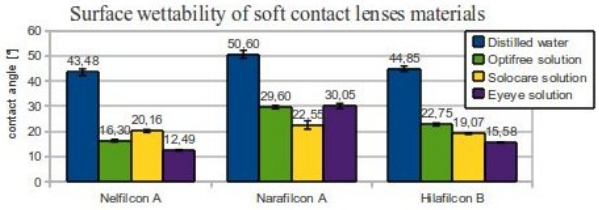

Fig. 5: Effect different solutions on the wettability of soft contact lenses

All tested soft contact lenses care solution are contact lenses well-wetting substance.

Figure 6 shows the hydrophilic properties of contact lens against different soft contact lens care solutions.

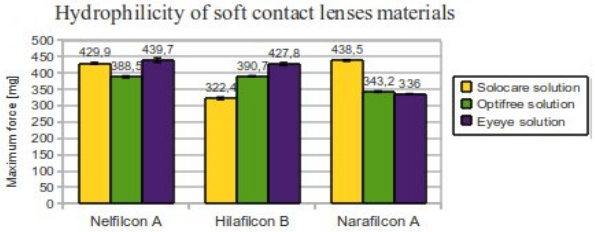

Fig. 6: Effect of care solutions on the hydrophilicity of soft contact lenses

The hydrophilicity of the contact lens changes, depending on the type of care solution.

Due to reflect actual conditions in a modified method of hydrophilicity measurement and results of research are similar to results obtained by other investigator, this method may soon replace the standard contact angle tests [2,3].

5. References

[1] Mittal K., Contact Angle, Wettability and Adhesion, Volume 4, VSP BV, Boston, (2006)

[2] Shirafkan A., Woodward G., Hull C., Port M., Surface wettability and hydrophilicity of soft contact lens materials, before and after wear, Ophthalmic and Physiological Optics, (1995), 15,p.529-532

[3] Shirafkan A., Woodward G., Hull C., A novel approach to measuring the wettability of rigid contact lenses. Mass measurement of the adherent liquid on the rigid lens surface, Ophthalmic and Physiological Optics, (1995), 15, p.575-583