MECHANICAL AND ABSORPTION PROPERTIES OF COMMERCIAL HYDROGEL DRESSINGS

SYLWIA ŁAGAN*, ANETA LIBER-KNEĆ

INSTITUTE OF APPLIED MECHANICS,
CRACOW UNIVERSITY OF TECHNOLOGY, POLAND
*E-MAIL: SLAGAN@MECH.PK.EDU.PL

[ENGINEERING OF BIOMATERIALS 153 (2019) 10]

Introduction

Hydrogels have been described as essential biomaterials in the field of tissue engineering, regenerative medicine, and drug delivery applications due to their specific characteristics [1,2,4]. The contact time of hydrogel with patient environment has important influence on development of biofilm (bacterial adhesion) on biomaterial surface. The aim of this work was comparison of three different structures (foam, fibrous and solid) of hydrogels through the mechanical tensile test, wettability test and the fluid absorption ability in the context of durability.

Materials and Methods

The objects of the study were Aquacel Ag (ConvaTec), Granuflex (ConvaTec) and Aqua-Gel (Kikgel) dressings.
The tensile tests were conducted with the use of the MTS tensile machine with the rate of 10 mm/min in the room temperature (23±2ºC) until broken of specimens. Each group was represented by three samples. The measurement base of specimens was 100 mm, the width was 10 mm and thickness was respectively 1, 3 and 4 mm. The contact angle (Θ) values were measured with the use of sessile drop method by the See System computer-based instrument produced by Advex Instruments. The volume of liquids drops were 0.5 μl. Three measurements liquids: (W) distilled water (Poch), (D) diiodomethane (Merck) and (G) glycerin (Chempur) were used. The changes in surface free energy (γ_S SFE) and its components were estimated by using analytical van Oss-Chauhury-Good (vOCG) model. Fluid absorption ability of hydrogels was tested for two liquids: distilled water and 0.9% salt saline solution, in room temperature trough 0h, 2h and 24 h.

Results and Discussion

The load-displacement curves for all materials after unpacking were shown in FIG. 1. Different character of hydrogels structures impacts on behavior under load, that is important issue for wound dressing. The maximal load obtained in tensile test were respectively for Aquacel, Aqua-Gel and Granuflex: 2.37±0.22, 0.89±0.07, 5.06±0.21 [N].

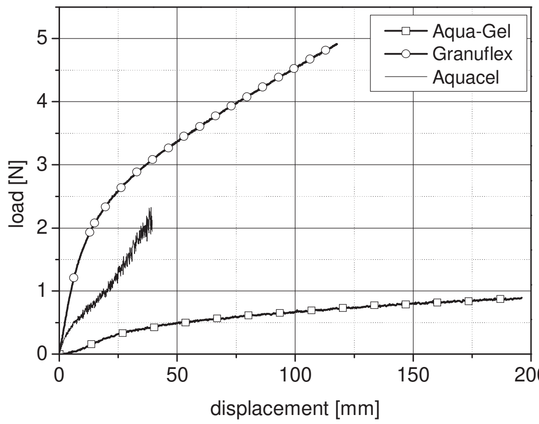

FIG. 1. Characteristics of tensile tests curves.

The instability of mass is shown in FIG. 2. The Aqua-Gel and Granuflex showed the stabilization of mass after ca. 7 days (in both liquids; the Aquacel has been defragmented in distilled water after 36 h, and in salt solution after 22 days. TABLES 1 and 2 present the values of contact angles and surface free energy. The decrease of contact angle of water was observed for Granuflex and Aqua-Gel.

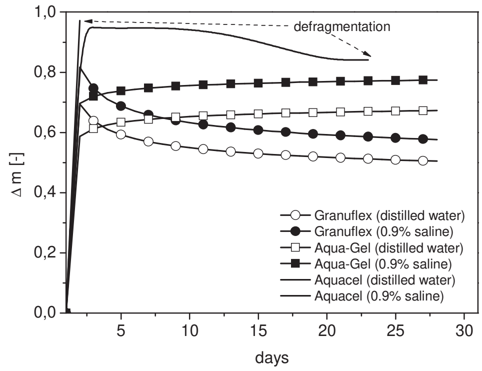

FIG. 2. Change in weight of hydrogels immersed in distilled water and 0.9% saline.

TABLE 1. The values of contact angles [°].

Time [h]	Material *	Θ_W	Θ_D	Θ_G
0	H2	108.1±7.9	60.1±7.6	101.8±6.7
2		79.8±3.1	62.7±2.8	77.18±3.1
24		67.2±6.2	47.6±7.1	58.8±10.3
0	H3 (-)	86.4±2.3	31.6±3.7	83.9±3.4
2		84.8±3.0	37.5±8.4	84.1±3.0
24		74.0±2.9	43.2±2.0	78.3±5.0
0	H3 (+)	107.2±6.9	61.5±4.2	108.4±8.9
2		100.4±6.9	51.47±8.9	89.0±6.9
24		88.4±11.7	63.7±4.1	92.7±5.3

*H1 – Aquacel (for H1 was no possibility to realize the wettability test), H2 - Aqua-Gel, H3- Granuflex (+/-) side with/without glue (inside/outside)

TABLE 2. The values of SFE and its components [mJ/m^2] for the surface of hydrogel dressings.

Time [h]	Material *	γ_S	γ_S^d	γ_S^p	γ_S^+	γ_S^-
0	H2	30.68	28.52	2.16	1.05	1.11
2		28.85	27.01	1.84	0.07	11.62
24		41.93	35.57	6.35	0.78	12.96
0	H3 (-)	49.47	43.55	5.91	1.23	7.14
2		47.10	40.85	6.25	1.09	8.90
24		44.59	37.95	6.64	0.60	18.25
0	H3 (+)	33.80	27.72	6.08	2.70	3.42
2		34.26	33.45	0.81	0.17	0.95
24		32.39	26.43	5.96	0.72	12.29

Conclusions

The results showed dispersive character of hydrogel surface in initial state, what is similar to the pig's skin [3], as well as good level of stability of properties necessary to the security wound in healing phases.

References

[1] Calo E., Khutoryanskiy V., Biomedical applications of hydrogels: A review of patents and commercial products, European Polymer Journal 65 (2015) 252–267.
[2] Kiselioviene S., Baniukaitiene O., Harkavenko V., Babenko N. A., Liesiene J., Cellulose hydrogel sheets for wound dressings, Cellulose Chemistry and Technology, 50 (9-10), 915-923(2016).
[3] Liber-Kneć A., Łagan S., Contact angle and surface free energy of fresh and stored pig's skin, Engineering of Biomaterials (2017), 20 (143), 10.
[4] Vedadghavami A., Minooei F., Mohammadi M.H., Khetani S., Kolahchi A.R., Mashayekhan S., Sanati-Nezhad A., Manufacturing of hydrogel biomaterials with controlled mechanical properties for tissue engineering applications, Acta Biomaterialia 62 (2017) 42–63.