ENVIRONMENTAL AGEING AND ITS EFFECT ON COMPRESSIVE PROPERTIES OF DENTAL COMPOSITE

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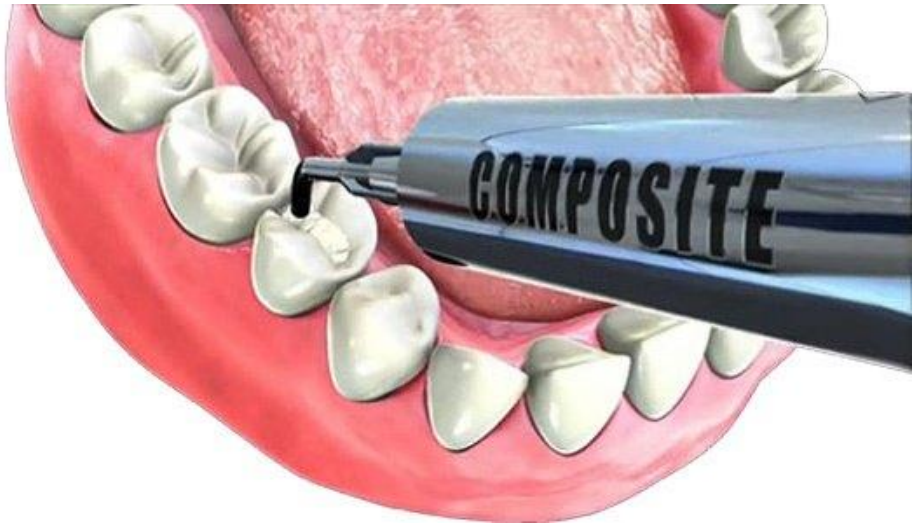
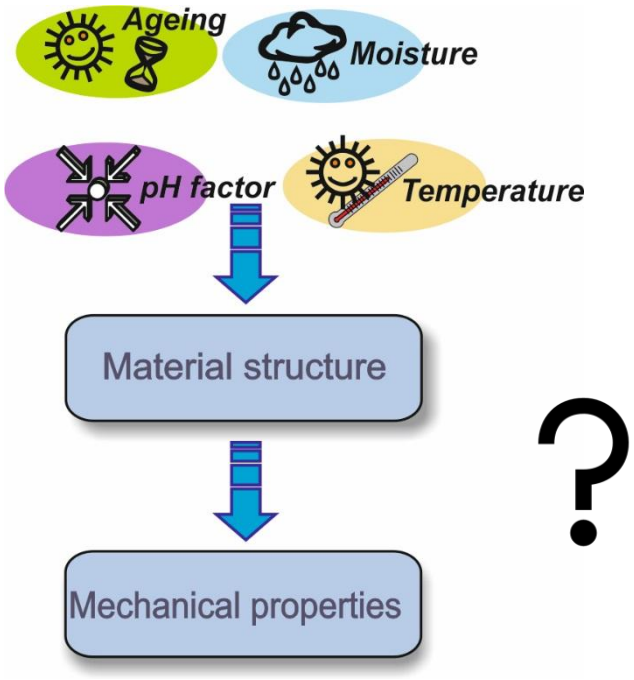
Motivation


COMPOSITE


Ageing
Moisture
pH factor
Temperature
Material structure
Mechanical properties
?

Aim

The aim of this study was to determine how compressive properties of commercially available dental composite material (CM) change in simulated intraoral conditions.

Tasks

1. To design and prepare the test specimens of dental CM.
2. Mechanical testing of the test specimens before the environmental ageing.
3. Environmental ageing of the test specimens in 3 liquid solutions with different pH factor at 50 °C until equilibrium moisture content.
4. Mechanical testing of the test specimens after the environmental ageing.

Materials and methods

Investigated material: Filtek™ Ultimate A2 Enamel (*3M ESPE*).

Matrix: bis-GMA, UDMA, TEGDMA and bis-EMA resins.

Fillers: silica and zirconia, inorganic filler content: 78.5 wt.%, size: 0.6-10 μm.

Pre-made prism
in a silicon mould.

Methods:

1. Compression tests by servo-hydraulic testing system *MTS 5T* at a speed rate 1 mm/min until failure, specimens: 10×5×5 mm according to ASTM D695;
2. Moisture absorption at 50 °C in solutions:

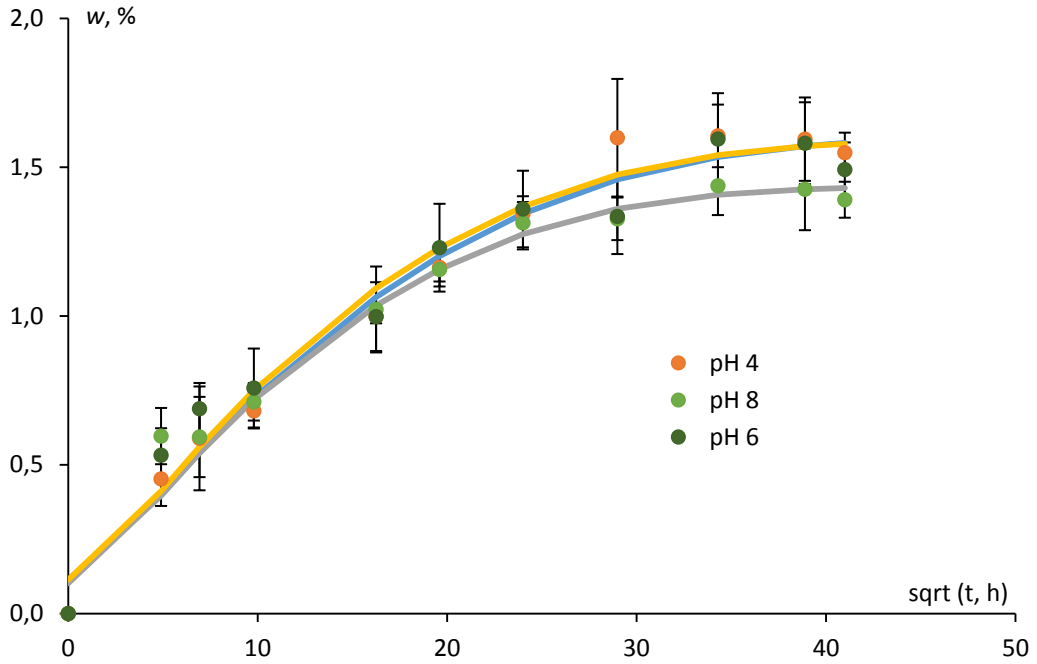
- water and vinegar solution (pH = 4);

- distilled water (pH = 6),

- alkaline mineral water (pH = 8).

Test specimens before
environmental ageing.

Results: water absorption

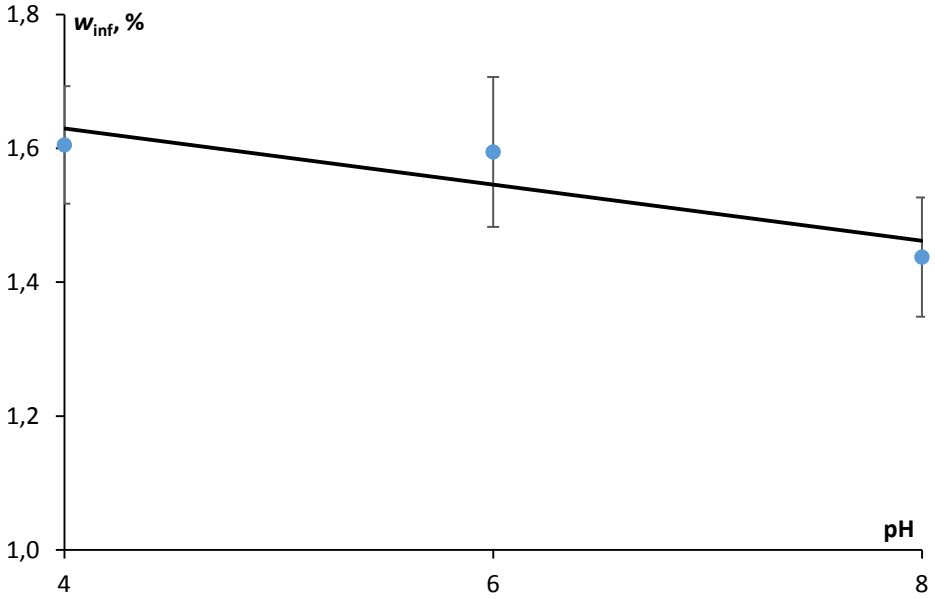


Moisture uptake in solutions with different pH (dots –experimental data, curves – evaluation by Fick's model for 3D mode of diffusion).

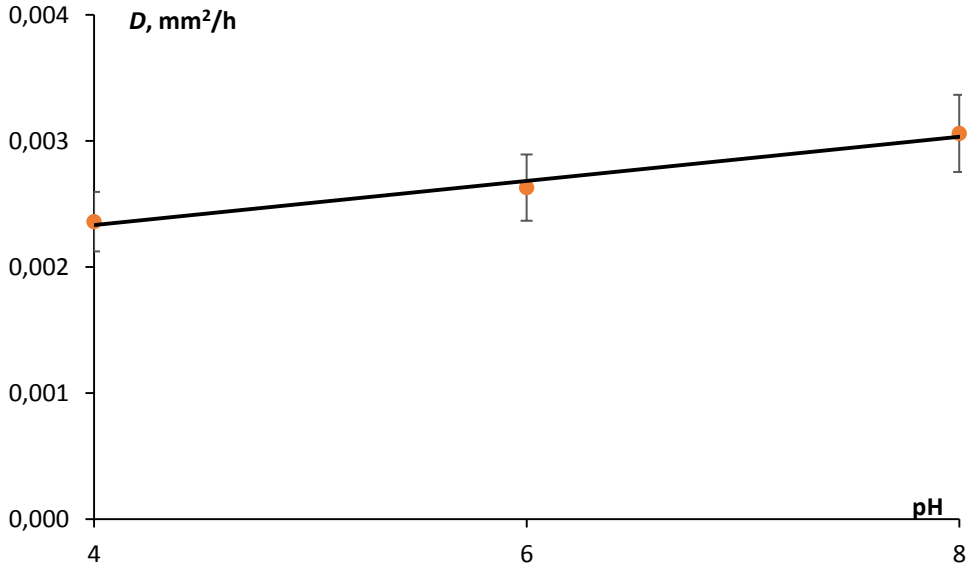
Fick's model for 3D mode of diffusion

$$w(t) = w_{\inf} - (w_{\inf} - w_0)\frac{8}{\pi^6}\sum_{k=1}^{\infty}\sum_{n=1}^{\infty}\sum_{m=1}^{\infty}\frac{\left[1-(-1)^k\right]^2\left[1-(-1)^n\right]^2\left[1-(-1)^m\right]^2}{k^2n^2m^2}\exp\left[-\lambda^2_{k,n,m}Dt\right]$$

Results: water absorption



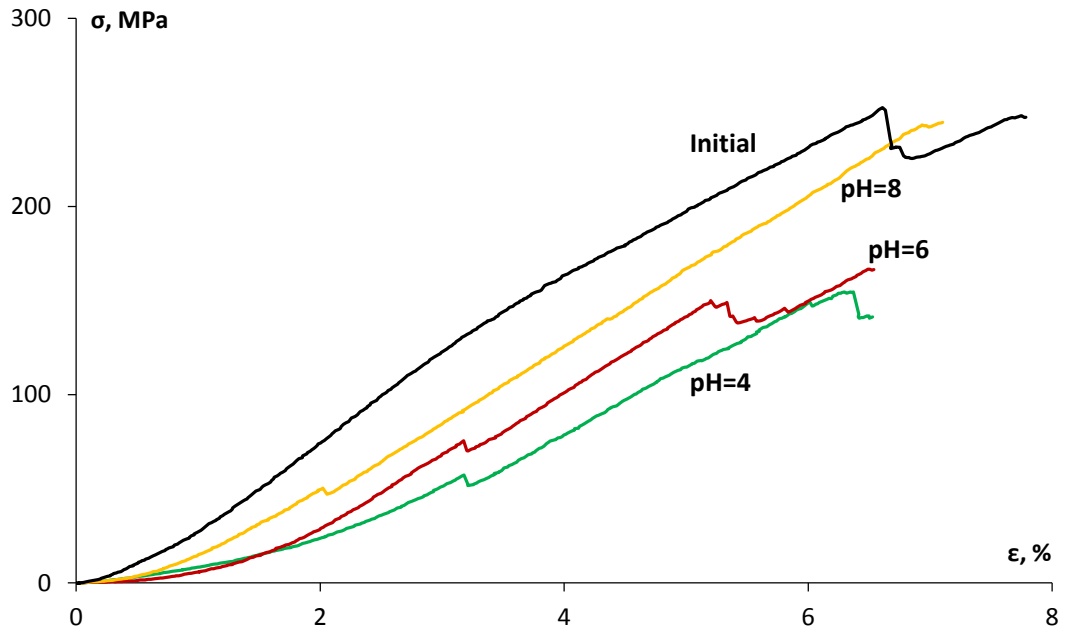
Equilibrium moisture content vs. pH of the solutions.



Diffusion coefficient vs. pH of the solutions.

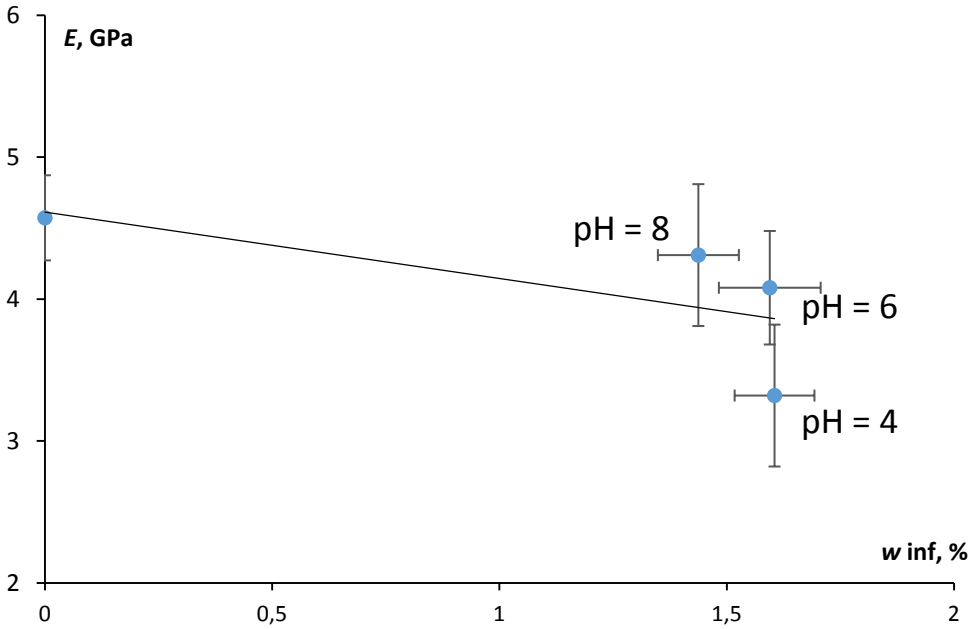
$$D = \frac{\pi h^2}{16t}\left(\frac{w(t) - w_0}{w_{\text{inf}} - w_0}\right)^2$$

Results:
compressive properties before and after environmental ageing

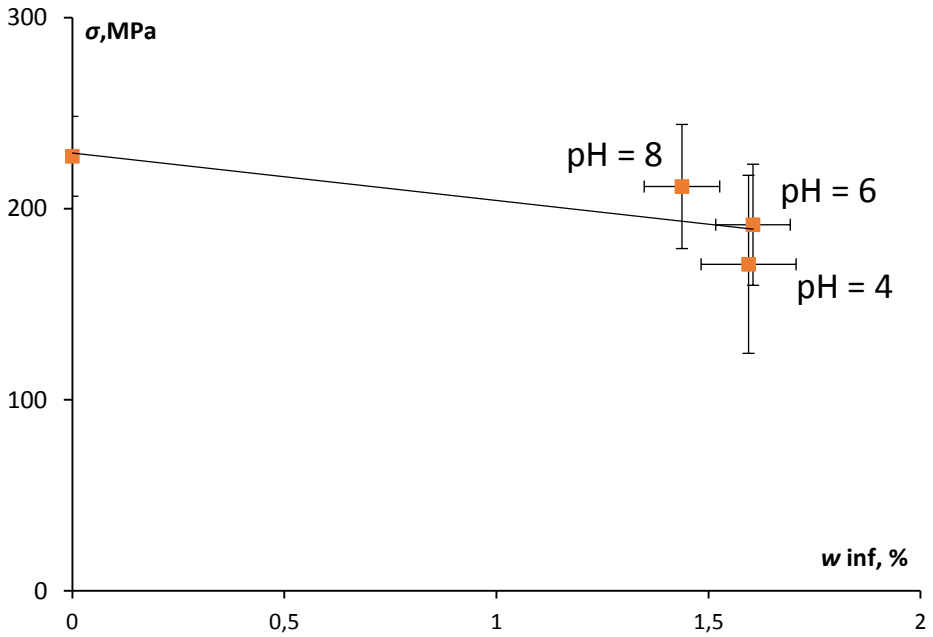


Representative stress-strain curves for the dental CM in different conditions.

Results:
compressive properties before and after environmental ageing



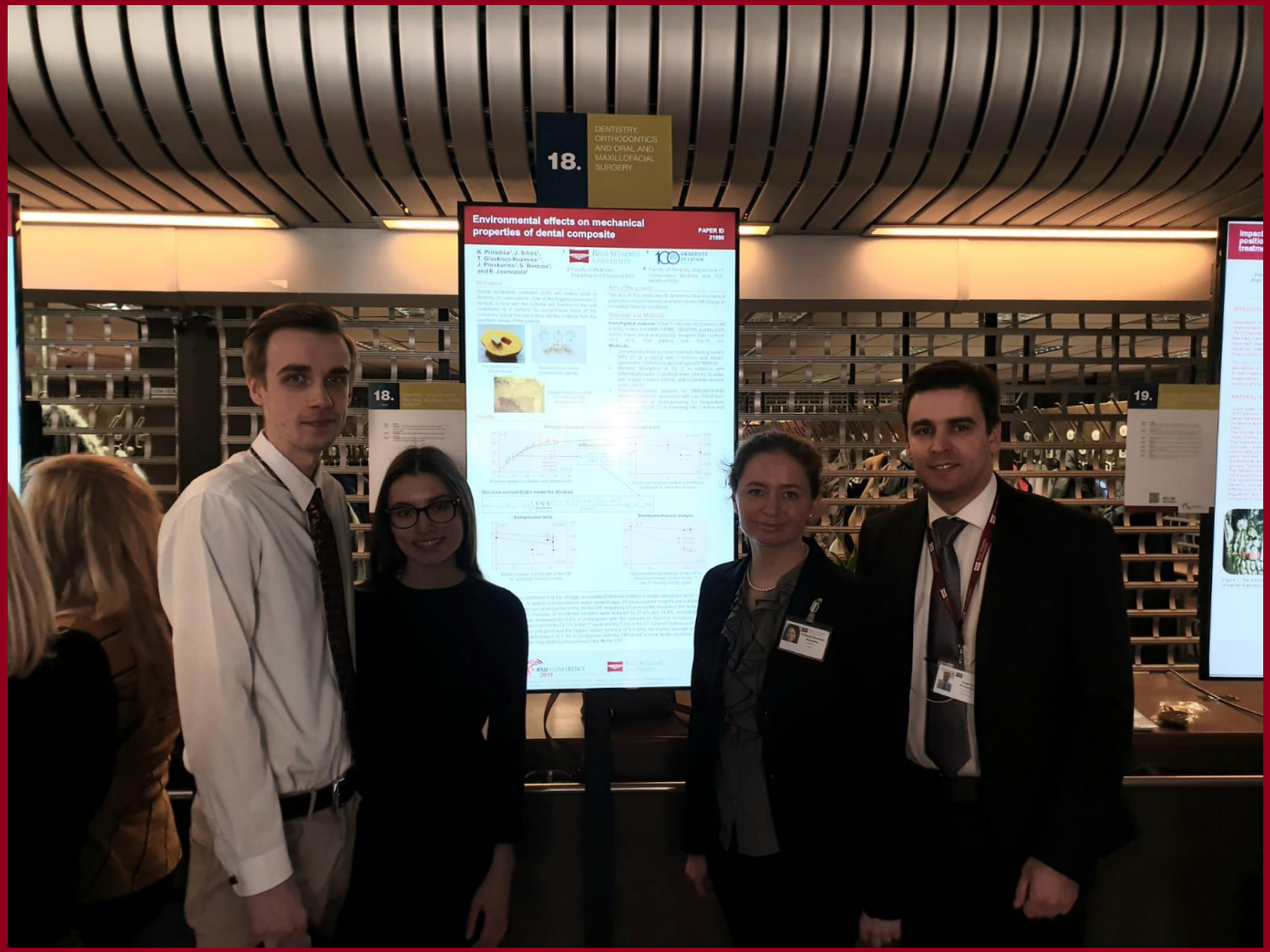
Elastic modulus of the CM vs. absorbed moisture content.



Strength of the CM vs. absorbed moisture content.

Conclusions

- It was experimentally confirmed that the storage in simulated intraoral conditions (water absorption at 50 °C in three solutions with pH is 4, 6, and 8) until equilibrium water content (app. 70 days) caused a significant reduction of compressive properties of the dental CM, negatively influencing the lifespan of the restauration.
- The strength and elastic modulus of moistened samples were reduced by 27.4% and 24.9%, accordingly, but the maximal deformation was increased by 0.4% in comparison with the samples in dry/initial conditions.
- The CM stored in solution with pH = 8 had the highest elastic modulus of 4.3 GPa, the highest strength of 211.7 MPa and the lowest maximal deformation of 7.3% in comparison with the CM stored in more acidic solutions (pH is 4 and 6), indicating to lower inner degradation phenomena of the dental CM.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Thank you!

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and keep smiling!