

Cieto poliuretāna putuplastu mehāniskās pārbaudes spiedē un stiepē

Konkurss "Zinātnisko institūciju zinātnes izcilības un snieguma finansējuma nodrošinājums pētniecības specializācijas, izcilības un ietekmes stiprināšanai - vienotas akadēmiskās un zinātniskās karjeras sistēmas reformas ieviešanai un zinātnes un inovācijas lomas palielināšanai".

Latvijas Zinātnes padome fundamentālo un lietišķo pētījumu projekts Nr. lzp-2020/2-0260 (01.12.2020. – 31.12.2021.)

"Anizometrisku nanomālu pildītāju daļiņu telpiskās izvietojumā ietekme uz zema blīvuma cieto poliuretāna putuplastu fizikālajām un mehāniskajām īpašībām".

Iesniedzējs: Latvijas Universitāte; sadarbības partneris LV Koksnes ķīmijas institūts (LV KĶI).

Finansējuma apmērs: EUR 100 389.

Pārbaudāmais materiāls: septiņi ar nanomāliem Cloisite30B pildīti (0 – 5 %) cietie poliuretāna putuplasti ar blīvumu $\rho_f = 230 - 250 \text{ kg/m}^3$ (Slēgtā veidnē formēti bloki).

Tabula. LV KĶI izgatavoto PUR putuplastu bloku dati.

Concentration η ; %	Mass m_n ; g	Mass difference Δm_n ; g	Relative mass difference R_{mn} ; %	Density ρ_{fan} ; kg/m^3	Density difference $\Delta \rho_{fan}$; kg/m^3	Relative density difference R_{dn} ; %	Space filling coeffic. P1; %	Porosity P2; %
0.00	250	0	0	238	0	0	18.6	81.4
0.25	253	3	1	240	-3	1	18.8	81.2
0.50	245	-5	2	233	5	2	18.2	81.8
1.00	249	-1	0	237	1	0	18.5	81.5
2.00	261	11	4	248	-11	4	19.3	80.7
3.00	244	-6	2	232	5	2	18.0	82.0
5.00	258	8	3	245	-7	3	18.8	81.2



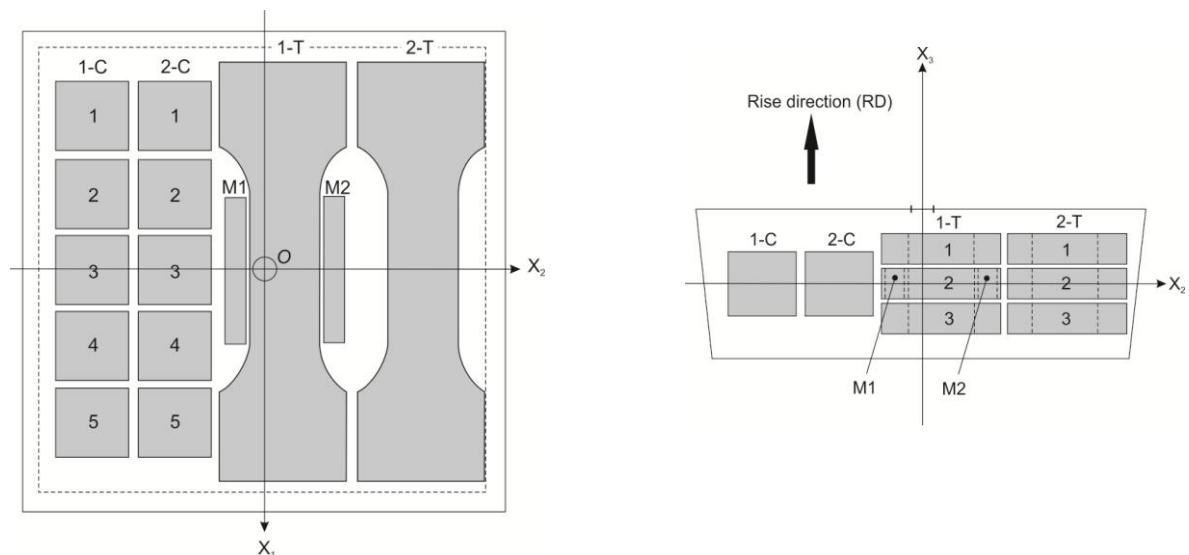
1.attēls. Cietie poliuretāna putuplasta bloks, kas uzputots slēgtā veidnē.

Mehāniskās pārbaudes

PU foams were tested in compression and tension according to the main principles of the standards:

- ISO 844:2021 “Rigid cellular plastics - Determination of compression properties” and
- ISO 1926:2009 “Rigid cellular plastics - Determination of tensile properties”.

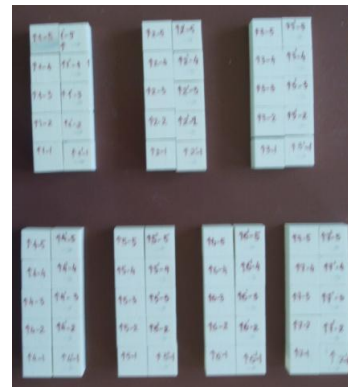
Stress-strain curves were measured on a testing machine Z-100, *Zwick GmbH & Co. KG*, with a video extensometer videoXtens 2-120 HP and a camera uEye 01-3483CP-M-GL. The five compression samples from the section 1-C were loaded parallel to the foams’ rise direction Ox_3 (Further - RD) and the five compression samples from the section 2-C: perpendicular to the RD (Parallel to axis Ox_1), Figure 4. The 6 tension samples from both sections 1-T and 2-T were loaded perpendicular to the RD (Parallel to axis Ox_1). PU foams exhibited a sufficient compression resistance for gripping of tension samples in the jaws of testing machine without supplementary installations.



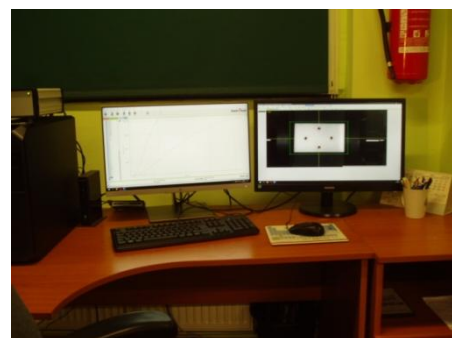
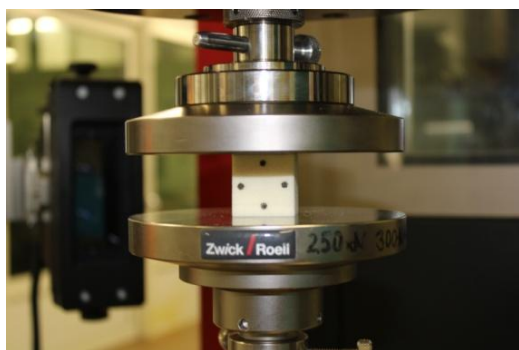
2.attēls. Spiedes „C”, stiepes „T” un mikroskopijas „M” paraugu izgatavošanas shēma.

Displacement was measured parallel to the loading direction a) In compression on a base 10 mm and b) In tension on a base 30 mm as well as perpendicular to the loading direction on a base 15 mm both in compression and in tension. The crosshead speed in compression: 10%/min (2.2 mm/min) and in tension: 10%/min (5 mm/min); ambient temperature 23.5°C. Due to limited height of the mould compressive samples had similar dimensions in transversal and lateral directions and a homogeneous compressive stress field could not be ensured in the measurement zone. Therefore the calculated values of moduli E_1 and E_3 are referred to as “Stiffness of the sample”. Mechanical characteristics were determined from the linear region of the stress-strain curves: a) Stiffness E_1 and E_3 , strength $\sigma_{11\max}$ and $\sigma_{33\max}$ and Poisson’s coefficients ν_{12} and ν_{31} in compression and b) Elasticity modulus E_1 , strength $\sigma_{11\max}$ and Poisson’s coefficient ν_{12} in tension.

Paraugus pārbaudīja Latvijas Universitātes Materiālu testēšanas laboratorijā, akreditācijas reģ. No LATAK-T-620-00-2019.



3.attēls. Stiepes paraugi (Notestēti) un spiedes paraugi.

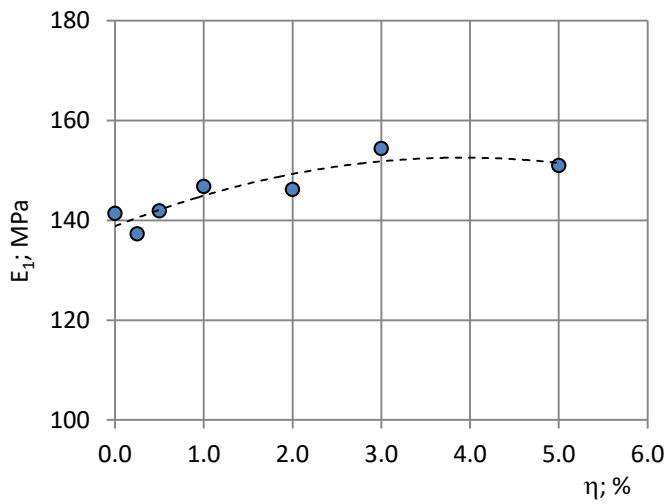


4.attēls. c) Testēšanas mašīna Z100 un video kamera uEye 01-3483CP-M-GL un b) Displejs ar mērbāzes iezīmēm uz spiedes parauga.

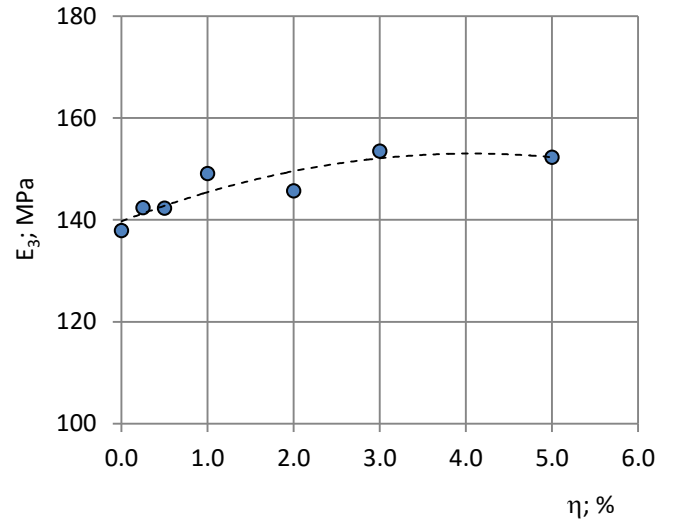
Datu arhīvi un rezultāti

Failu mapēs „MMI3 spiede” un „MMI3 stiepe” saspiestā veidā ir pieejami faili (*.xls) ar PUR putuplastu slodzes deformācijas raksturlīknēm un citiem datiem.

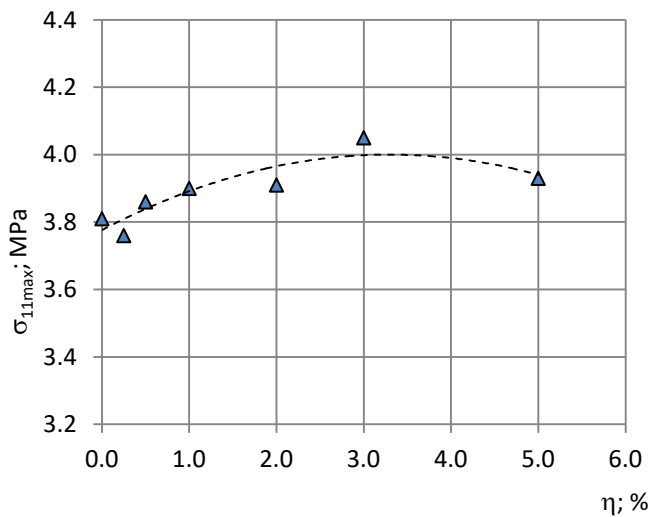
1)



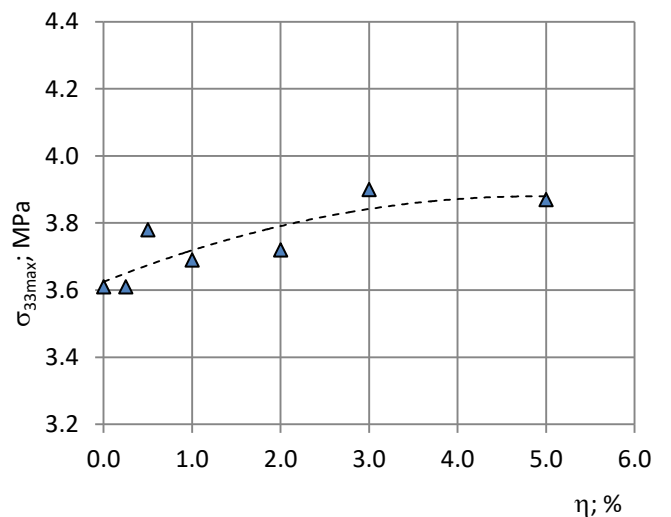
2)



3)

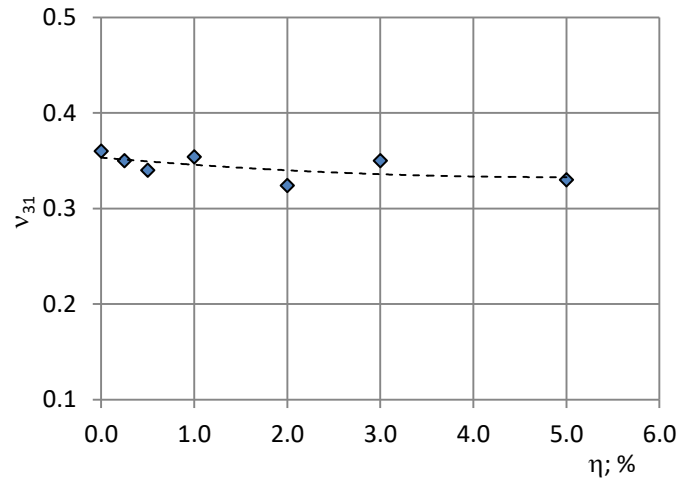
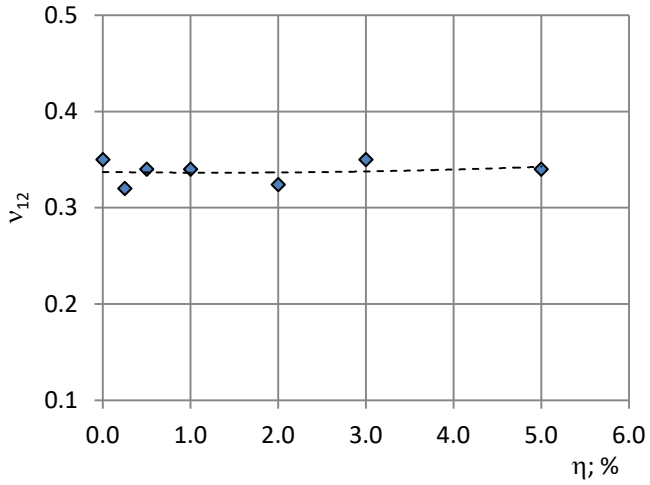


4)

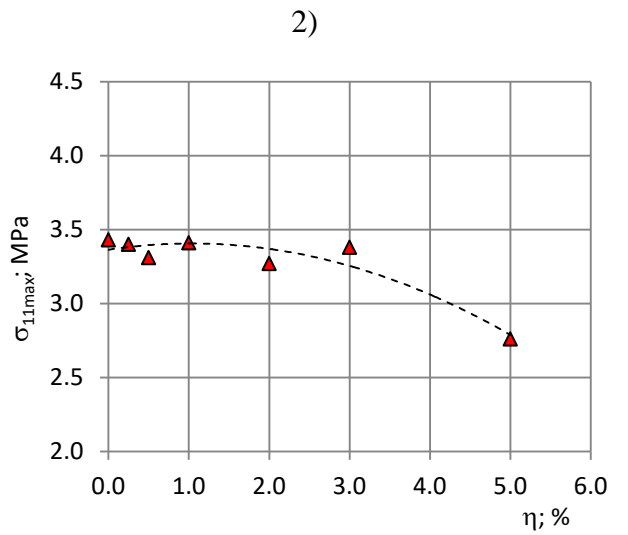
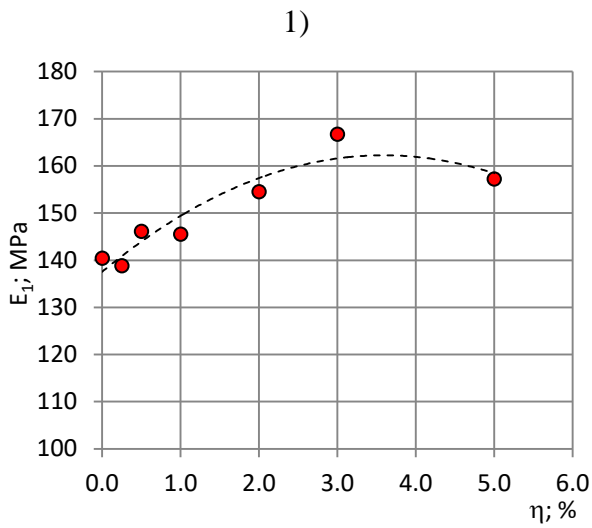


5)

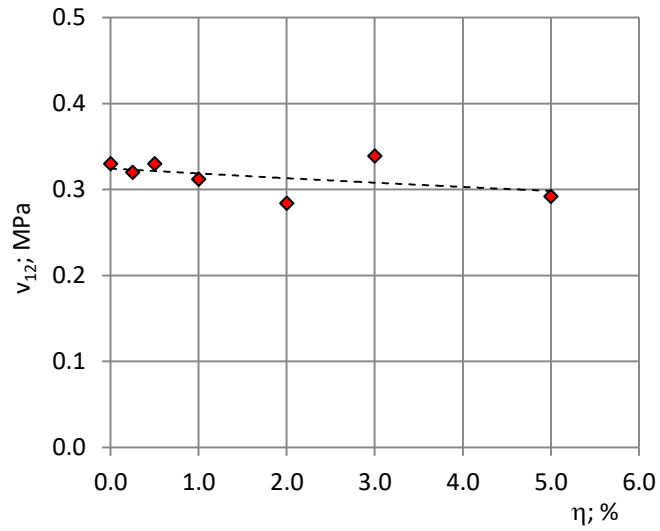
6)



5.attēls. Stiffness 1) E_1 and 2) E_3 , strength 3) $\sigma_{22\max}$ and 4) $\sigma_{33\max}$, Poisson's coefficients 5) ν_{12} and 6) ν_{31} in compression, in dependence of filler's concentration ($\rho_{\text{fcom}} = 222.7 \text{ kg/m}^3$).



3)



6.attēls. 1) Stiffness E_1 , 2) Strength $\sigma_{11\max}$ and 3) Poisson's coefficient v_{12} in tension, in dependence of filler's concentration ($\rho_{\text{fcom}} = 222.7 \text{ kg/m}^3$).