



Predobrada biomase energetske kulture i izolacija lignoceluloznih vlakana inovativnom metodom

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Završna diseminacijska konferencija projekta KK.01.1.1.04.0091 "BIOKOMPOZITI"
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Europska unija
Zajedno do fondova EU

Prirodna vlakna

Prema Pravilniku o sirovinskom sastavu, nazivima i označavanju tekstila (NN 158/08 i 79/2007) Uredbi EU 1007/2011 o nazivima tekstilnih vlakana i povezanom označavanju i obilježavanju sirovinskog sastava tekstilnog proizvoda

Biljna vlakna Životinjska vlakna Anorganska vlakna

Sjemenska vlakna

- Pamuk
- Kapok

Stabljična vlakna

- Lan
- Kudeljja
- Juta
- Kenaf
- Ramija
- Brnistra (žuka)
- Bengalska ili bombajska konoplja (sunvlakno)

Vlakna iz lišća

- Sisal
- Henekan
- Maquey
- Abaka (Manila)
- Vlakna sanseverije
- Agava
- Alfa
- Novozelandski lan

Vlakna od ploda

- Kokos

Keratinska vlakna

- Ovce
 - Vuna
- Koze
 - Moher
 - Kašmir
 - Kašgora
 - Kostrijet
 - Obična kozja dlaka
- Deve
 - Devina dlaka
- Ljame
 - Ljama
 - Alpaka
 - Vikunja
 - Gvanako
- Zečevi
 - Dlaka angorskog zeca
 - Dlaka običnog zeca
- Ostale životinje
 - Strune i čekinje
 - ✓ Konjske dlake
 - ✓ Svinjske dlake
 - ✓ Kravljje dlake
 - Perije i paperje
 - Jak

Fibroinska vlakna

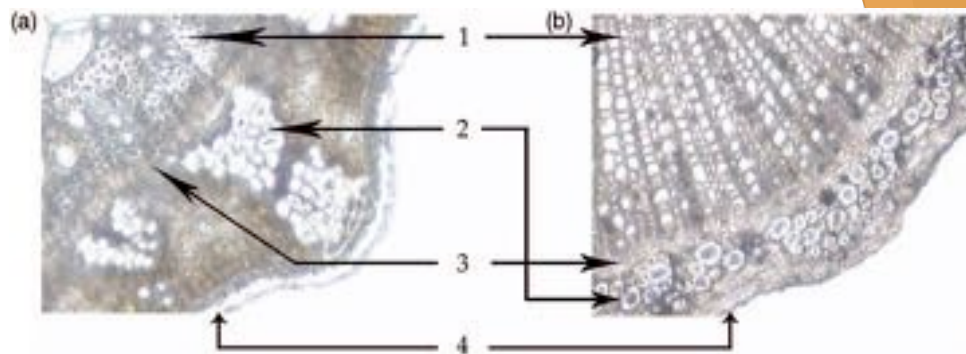
- Svila dudovog svilca
- Divlje svile
 - Tusah
 - Eria
 - Anafe
- Paukova svila (paučina)
- Morska svila

Anorganska vlakna

- Azbest

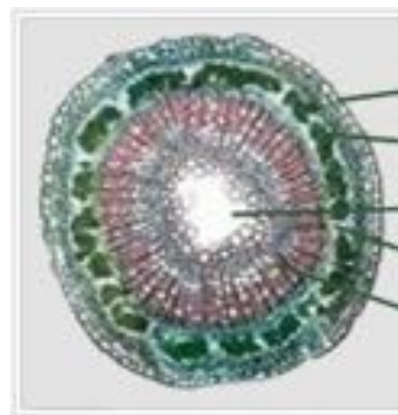
Nova vlakna npr. vlakna iz esparto trave, miskantus vlakna, vlakna borovog prelica i dr.

u skoroj budućnosti



Poprečni presjek stabljike (a) brnistre i (b) lana

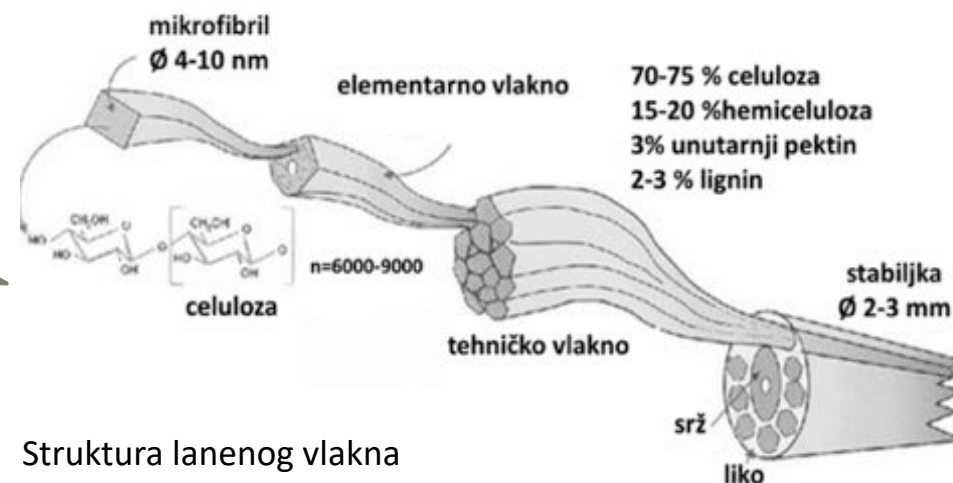
- 1 - ksilem
- 2 - sklerenhim (vlakna)
- 3 - floem
- 4 - epiderma



- Epiderma
- Vlakna
- Zrak
- Pektin

Poprečni presjek stabljike lana

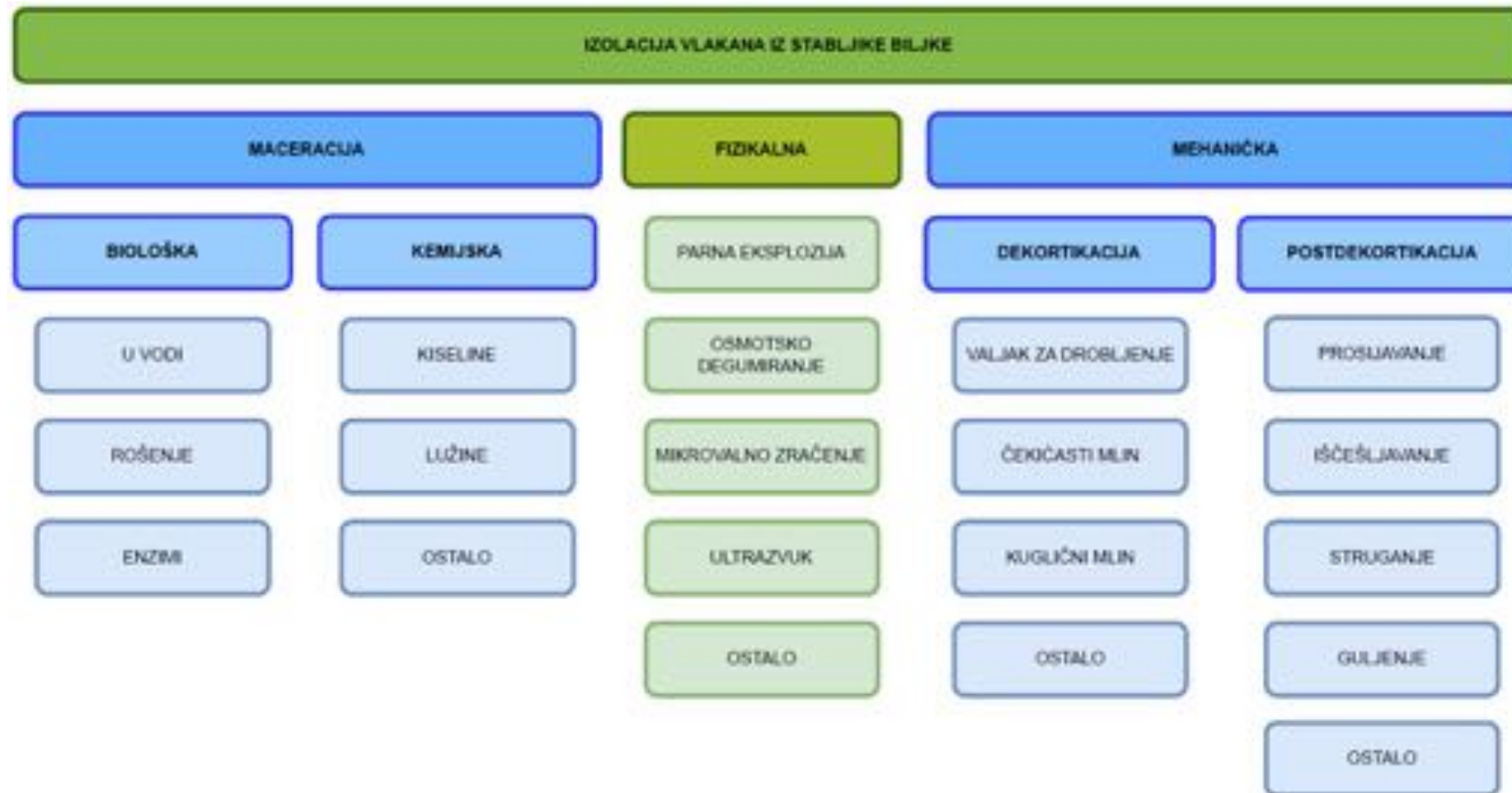
Lignin i pektin u stabljici!!!



Struktura lanenog vlakna

Klasifikacija prirodnih vlakna prema Uredbi EU 1007/2011 o nazivima tekstilnih vlakana i povezanome označavanju i obilježavanju sirovinskoga sastava tekstilnoga proizvoda

Izolacija vlakana



Različiti načini izolacije vlakana iz stabljike biljke

4 kulture: 2 samonikle (Divovska trska i brnistra) i 2 energetske (Miskantus i Virdžinijski sljez)



1) 5 % NaOH i (5, 10, 15 %) H₂O₂

Koristili zbog većih dimenzija ulazne sirovine i skupljanje ostatka za agronomiju

2) H₂O₂, CA (limunska kiselina), EDTA (komplekson III), H₂O



Inovativni postupak uz kombinaciju s fizikalnom metodom korištenjem mikrovalnog zračenja





Otpadna kemikalija

Kruti ostatak



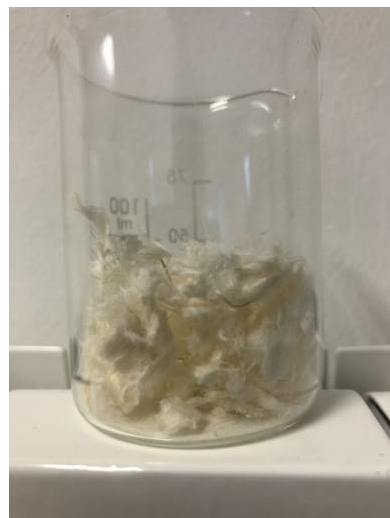
BIOGORIVA



BIOPLIN



PELETI



Vlakno
Divovske
trske

Brnistra (*Spartium junceum* L.)



1) 5 % NaOH



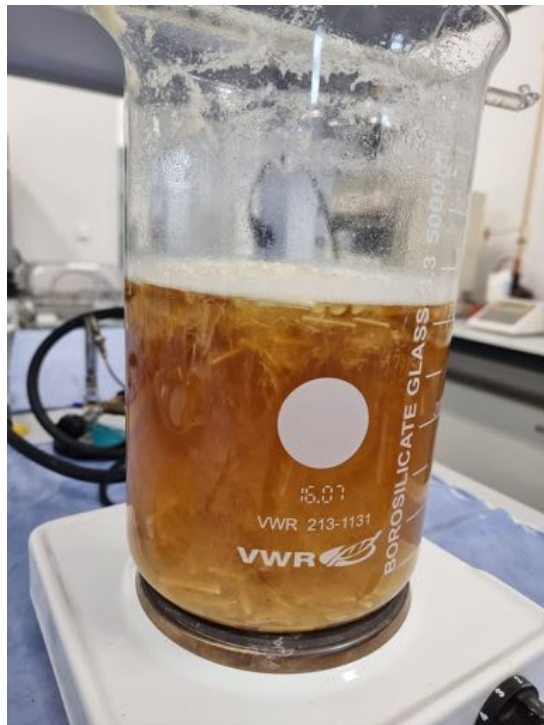
Miskantus (*Mischantus x giganteus*)



1) Organosolv (170 °C, 60 min, 14 bar)

Suradnja s Univerza v Mariboru, Fakulteta za strojništvo





2) 5 % H_2O_2 i 5 % NaOH



Ostatak

Vlakna



3) H_2O_2 , CA, EDTA, H_2O



Vlakna

Virdžinijski sljez (*Sida hermaphrodita* L.)

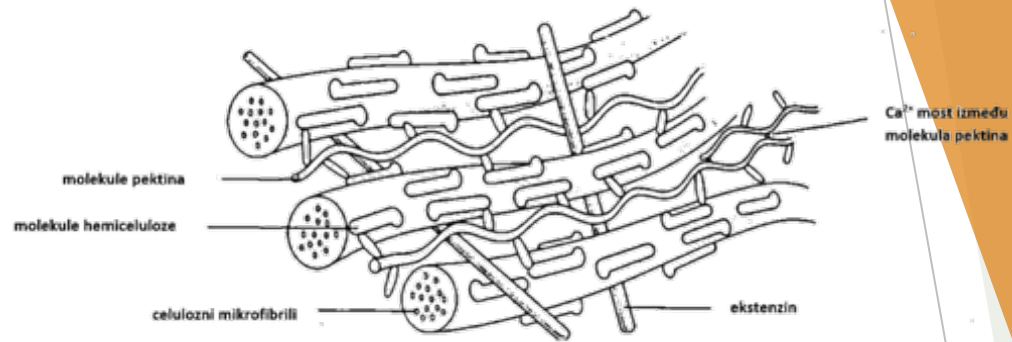
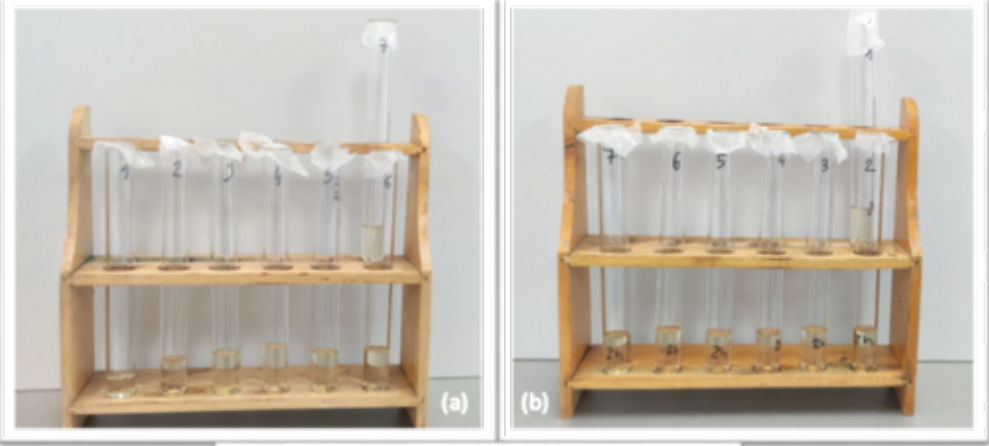
1) 5 % NaOH



Ostatak



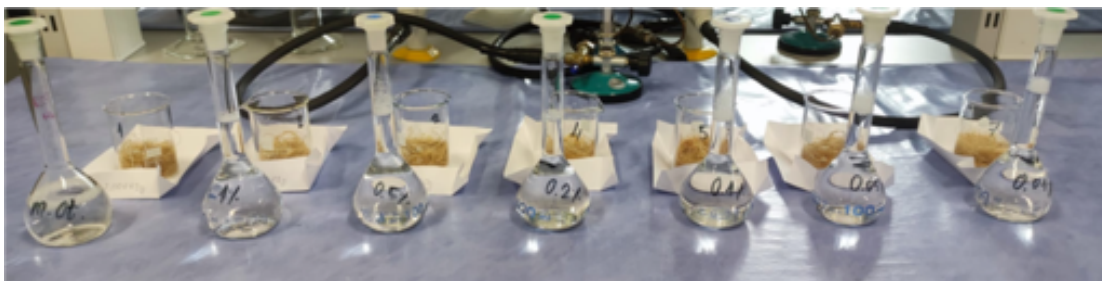
Vlakna Virdžinijskog sljeza



Strukturni protein „ekstenzin” međusobno isprepliće mikrofibrilne snopiće kako bi mu ojačalo strukturu. Djelovanjem proteaze na ekstenzin rezultira oslobađanjem elementarnih vlakana iz snopića tehničkog vlakna (defibrilacija).

2) Enzimi korišteni sa svrhom oslobađanja elementarnih vlakana iz već postojećeg tehničkog vlakna

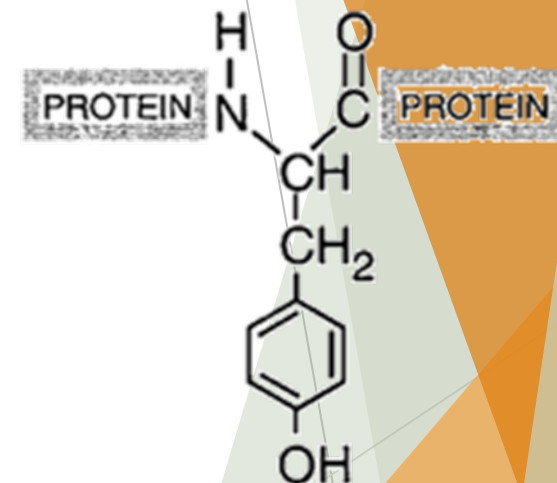
Uzorak	Opis	m_p [g]	$m_{\text{nakon obrade}}$ [g]	%	$m_{\text{otopljeno}}$ [g]
1	0%E	2,00869	1,97459	1,70	0,03410
2	1%E	2,00282	1,94341	2,97	0,05941
3	0.5%E	2,00460	1,97250	1,60	0,03210
4	0,2%E	2,00044	1,94862	2,59	0,05182
5	0.1%E	2,00866	1,98749	1,05	0,02117
6	0,05%E	2,00826	1,97790	1,51	0,03036
7	0,01%E	2,00461	1,97198	1,63	0,03263



Pikovi u području λ_{max} 244 i 300 nm koriste se za određivanje prisutnosti spojeva koji sadrže aromatske prstene.

Mjerenjem optičke gustoće možemo usporediti “prozirnost” otopina ili procijeniti koncentraciju neke otopljene tvari u tim otopinama.

Uzorak	Opis	OD ₂₄₄			OD ₃₀₀			OD ₃₄₀		
		1h	2h	3h	1h	2h	3h	1h	2h	3h
7	0,01%E	0.668	1.032	1.582	0.656	0.725	0.781	0.525	0.576	0.592
6	0,05%E	0.419	0.970	1.396	0.557	0.686	0.797	0.458	0.539	0.615
5	0,1%E	1.271	0.578	1.080	0.806	0.539	0.682	0.601	0.408	0.500
4	0,2%E	1.131	1.055	1.156	0.776	0.716	0.728	0.622	0.569	0.576
3	0,5%E	1.739	0.956	1.426	1.018	0.686	0.811	0.813	0.550	0.629
2	1,00%E	1.905	1.172	1.598	1.055	0.765	0.854	0.859	0.622	0.700
1	0%E	0.937	1.156	1.474	0.714	0.765	0.785	0.562	0.613	0.613



Molekularna struktura biljnog proteina ekstenzina



3) Doktorski rad u tijeku - preliminarna istraživanja

- 1. 5 % NaOH, MW (P = 900 W)
20 min
- 2. 5 % NaOH, MW (P = 900 W)
10 min + Enzim proteaza
(0,05 %; 0,5 % i 1 %)
sušionik na 50 °C, 48 h
- 3. H₂O₂ + CA + H₂O (bez
EDTA), MW (P= 900 W), 25
min

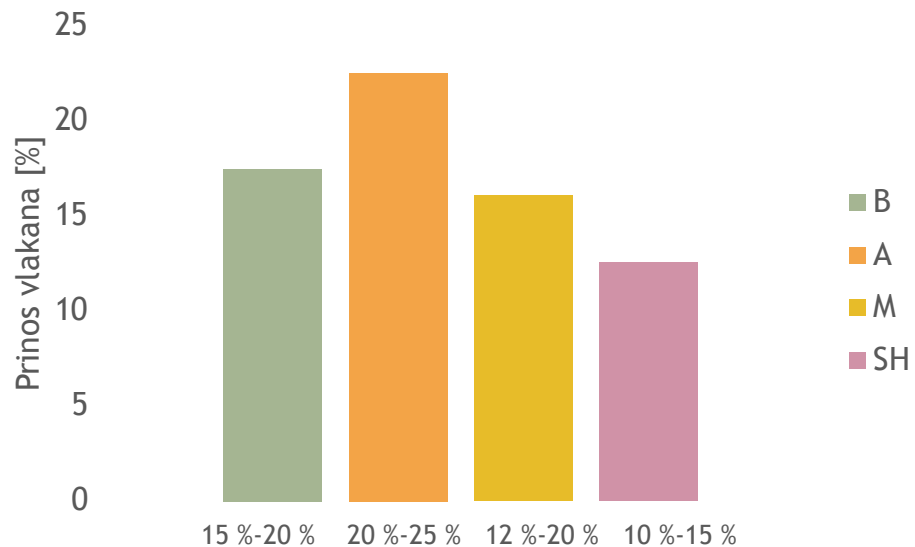


Vlakno

Ostatak



Karakterizacija izoliranih vlakana

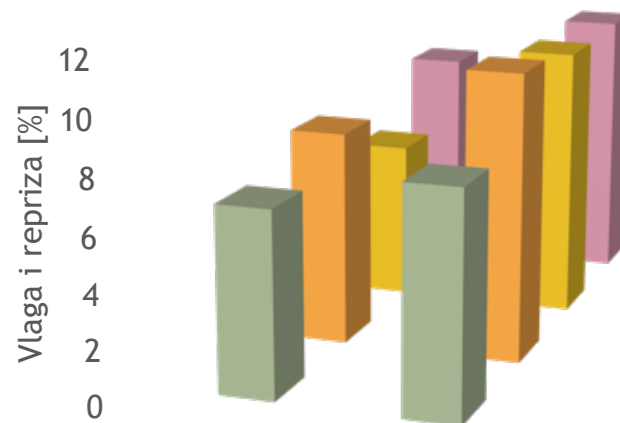


B (Brnistra): 5 % NaOH

A (Divovska trska): 5 % NaOH + 10 % H₂O₂

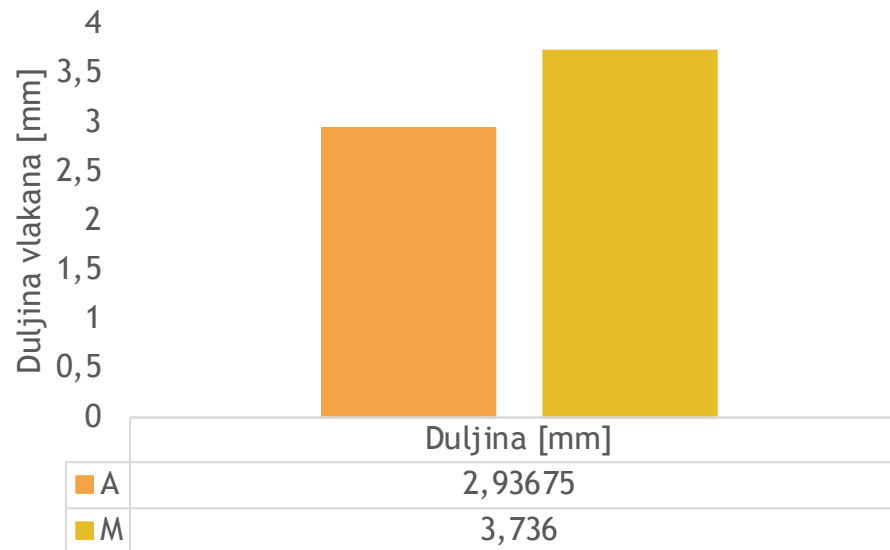
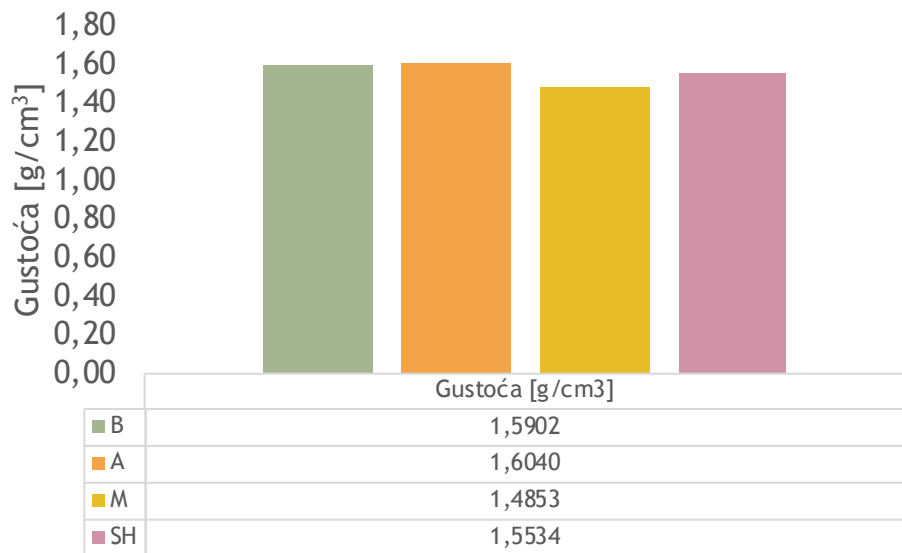
M (Miskantus): 5 % NaOH + 5 % H₂O₂

SH (Virdžinijski sljez): 5 % NaOH



	Vlaga [%]	Repriza [%]
B	6,85629247	8,215477859
A	7,975920219	10,68351411
M	5,966527981	10,16447348
SH	8,266207866	10,28586864

Karakterizacija izoliranih vlakana



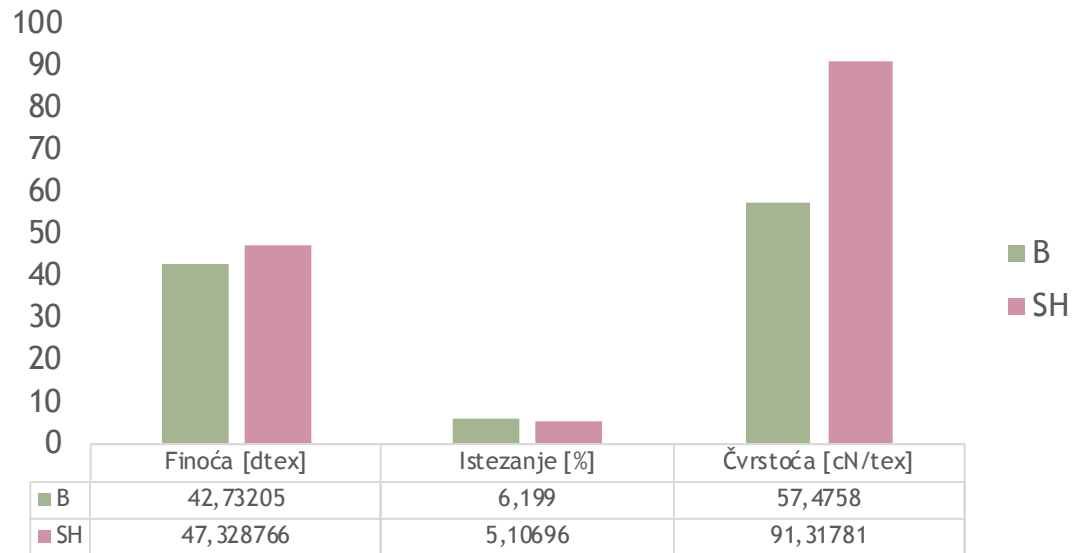
B (Brnistra)
 A (Divovska trska)
 M (Miskantus)
 SH (Virdžinijski sljez)



	Vlakno	Promjer (µm)	Duljina (mm)	Repriza (%)	Gustoća (g/cm ³)
Sjemenska vlakna	Pamuk	10 - 22	12 - 64	8,5	1,55
Stabljična vlakna	Lan	40 - 600	5 - 900	7	1,4 - 1,5
	Konoplja	10 - 500	5 - 56	8	1,3 - 1,6
	Juta	25 - 200	1,5 - 120	12	1,4 - 1,8
	Brnistra	10 - 200	5 - 900	8	1,55 - 1,6
Vlakna iz lišća	Sisal	8 - 200	900	11	1,2 - 1,5
Vlakna od ploda	Kokos	10 - 460	20 - 150	13	1,1 - 1,4

Karakterizacija izoliranih vlakana

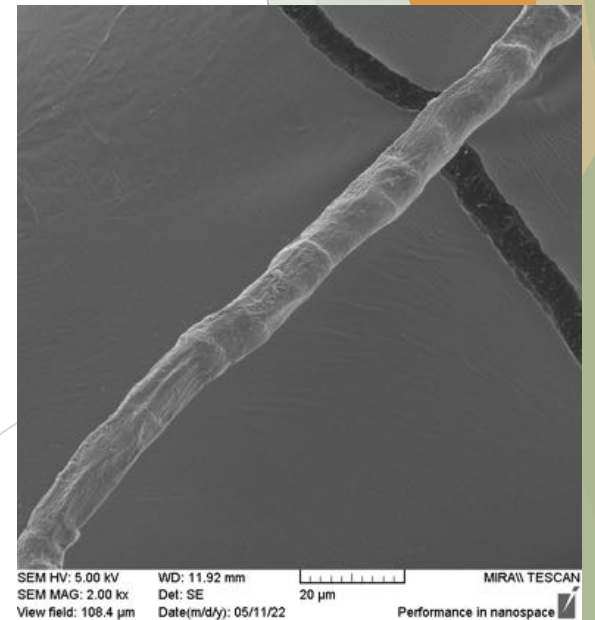
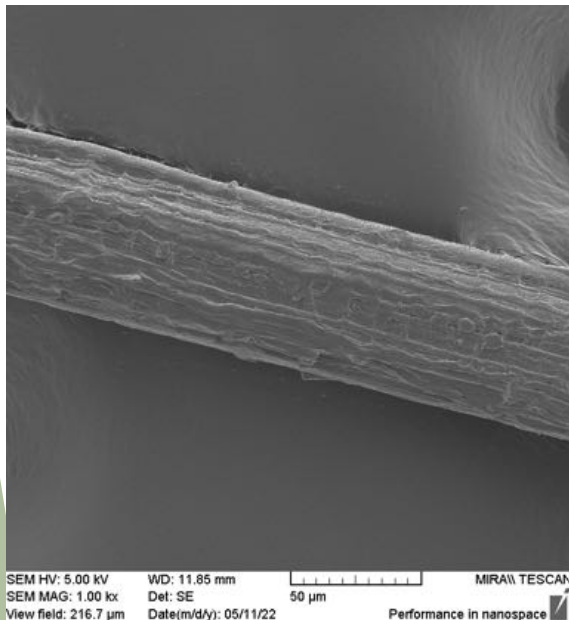
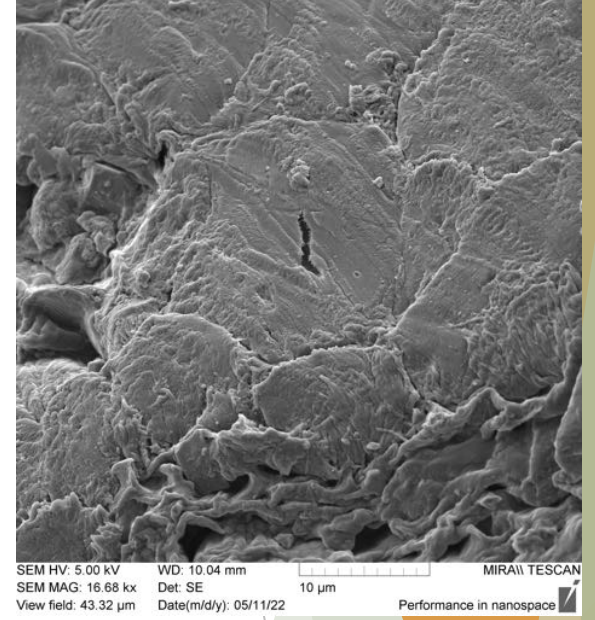
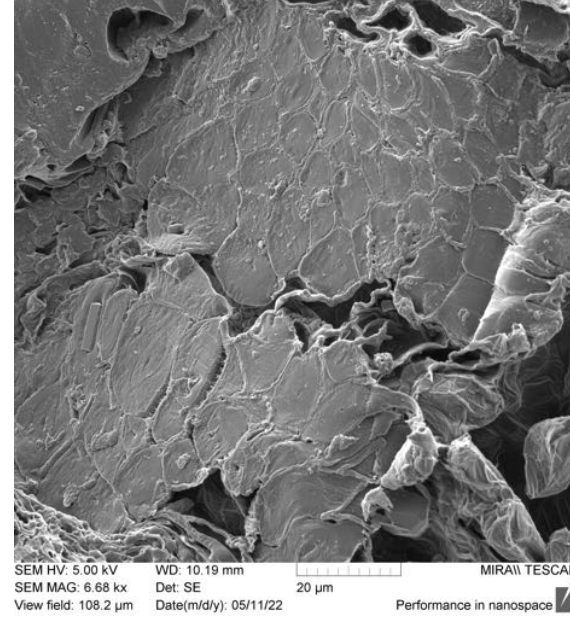
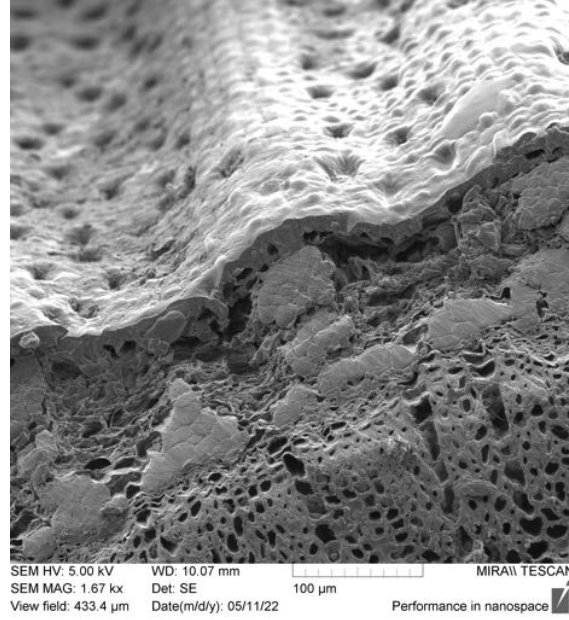
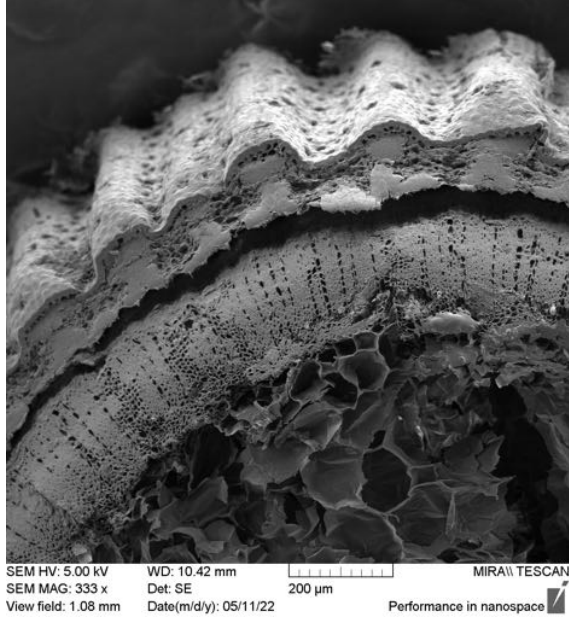
B (Brnistra)
SH (Virdžinijski sljez)



	Vlakno	Vlačna Čvrstoća (MPa)	Modul (GPa)	Istezanje (%)
Sjemenska vlakna	Pamuk	287 - 597	5,5 - 12,6	3 - 10
Stabljikna vlakna	Lan	345 - 900	27 - 80	1,2 - 1,6
	Konoplja	300 - 800	30 - 70	1,3 - 1,6
	Juta	200 - 800	10 - 55	1,4 - 1,8
	Brnistra	500 - 1100	15 - 20	3 - 9
Vlakna iz lišća	Šisal	100 - 800	9 - 28	2 - 3
Vlakna od ploda	Kokos	13 - 220	4 - 6	15 - 40

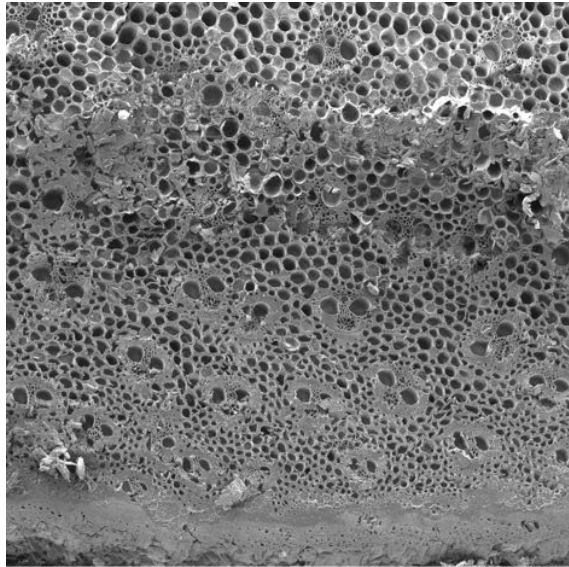
Karakterizacija izoliranih vlakana

Brnistra

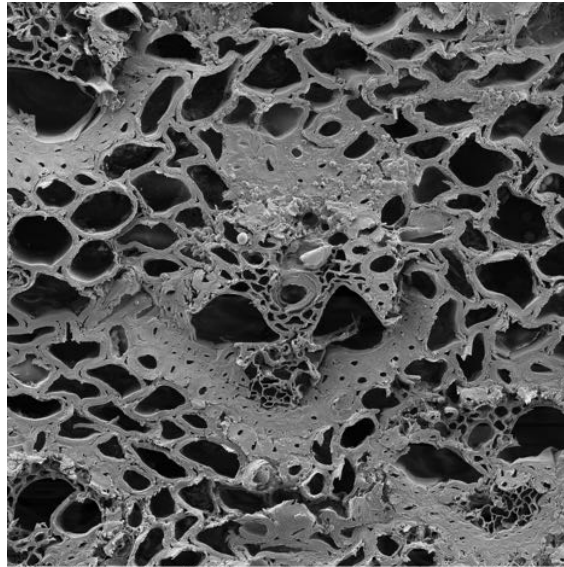


Karakterizacija izoliranih vlakana

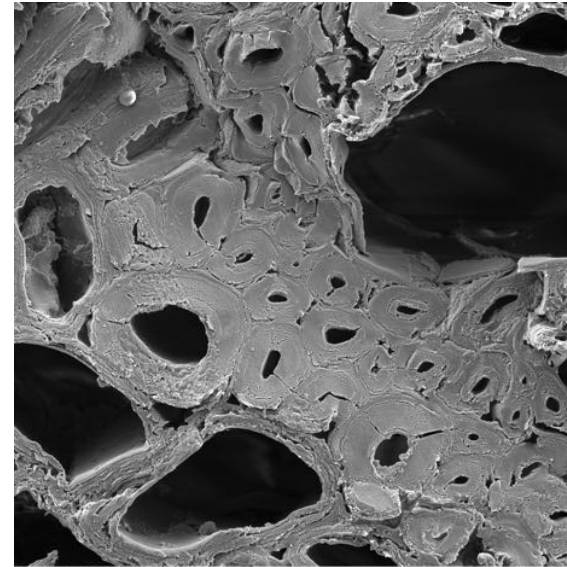
Divovska trska



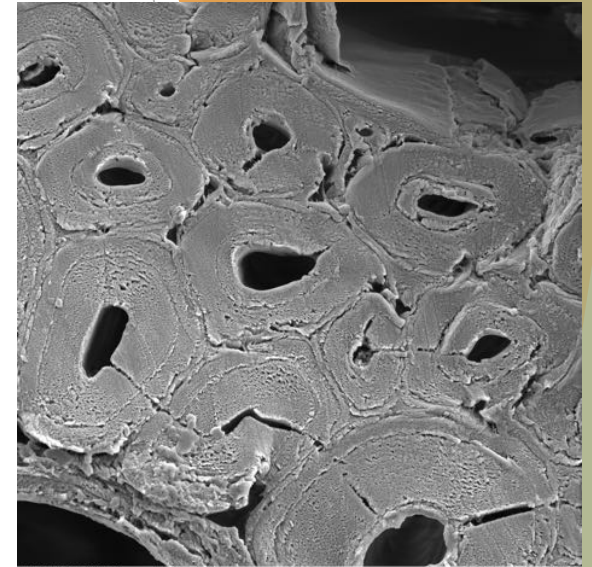
SEM HV: 5.00 kV WD: 11.02 mm
SEM MAG: 333 x Det: SE
View field: 2.17 mm Date(m/d/y): 05/10/22
MIRA\ TESCAN
500 µm
Performance in nanospace



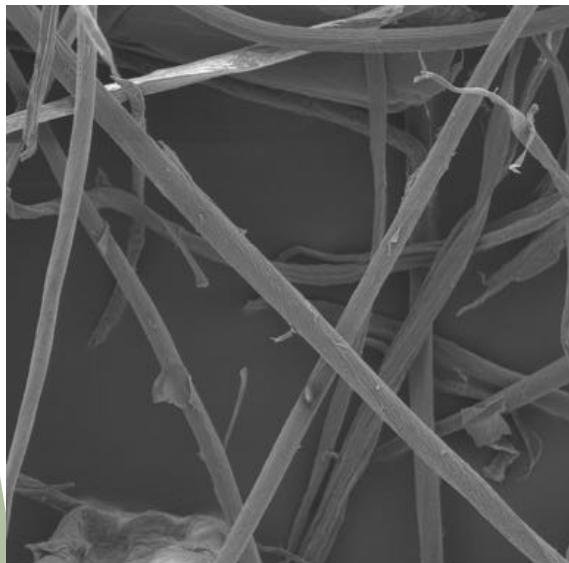
SEM HV: 5.00 kV WD: 10.68 mm
SEM MAG: 1.67 kx Det: SE
View field: 433.4 µm Date(m/d/y): 05/10/22
MIRA\ TESCAN
100 µm
Performance in nanospace



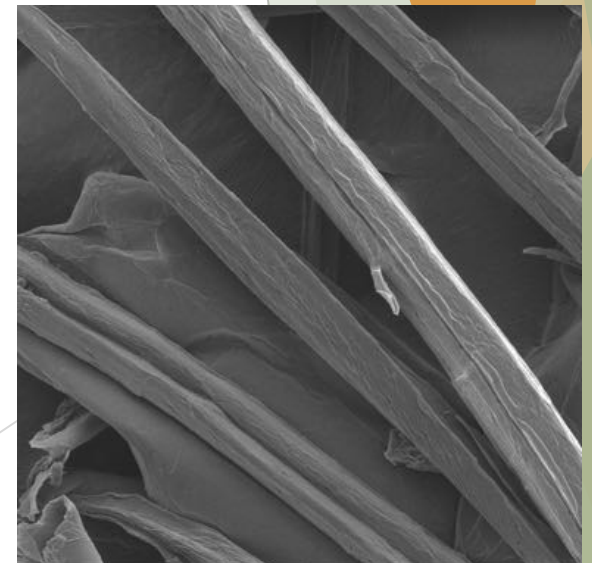
SEM HV: 5.00 kV WD: 10.67 mm
SEM MAG: 6.67 kx Det: SE
View field: 108.3 µm Date(m/d/y): 05/10/22
MIRA\ TESCAN
20 µm
Performance in nanospace



SEM HV: 5.00 kV WD: 10.68 mm
SEM MAG: 16.66 kx Det: SE
View field: 43.36 µm Date(m/d/y): 05/10/22
MIRA\ TESCAN
10 µm
Performance in nanospace



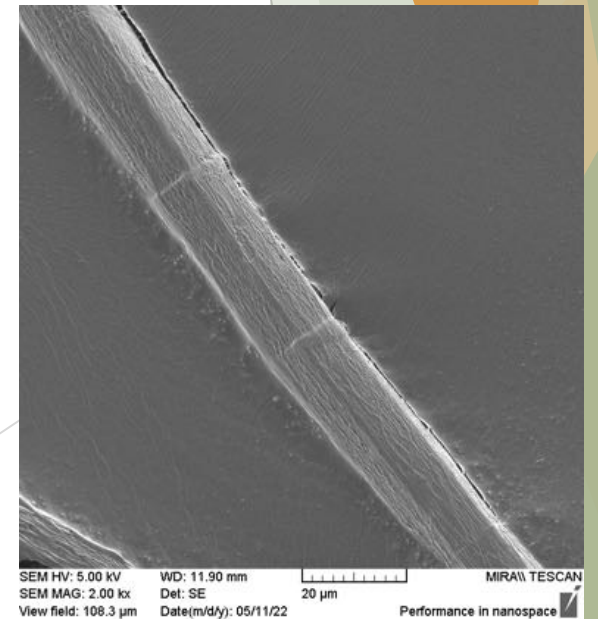
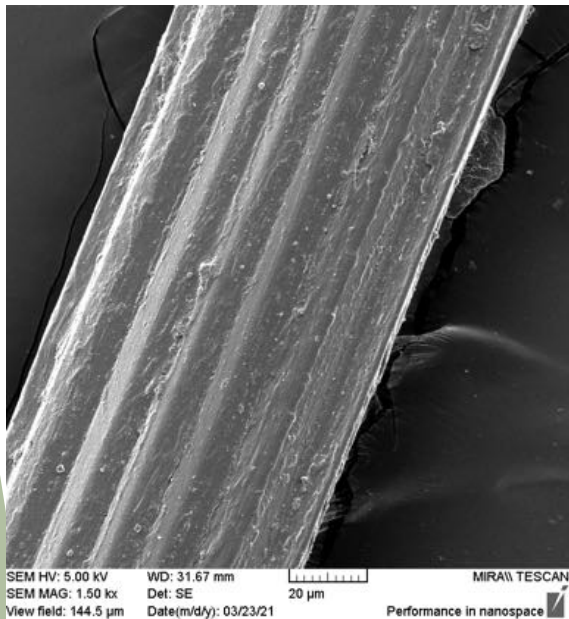
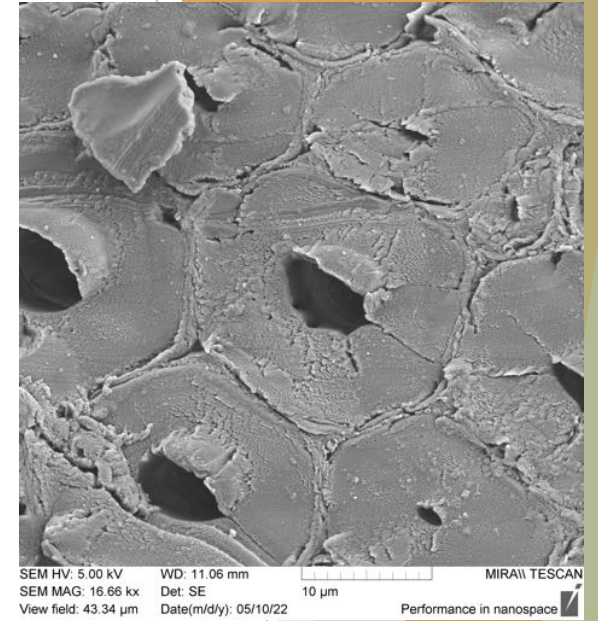
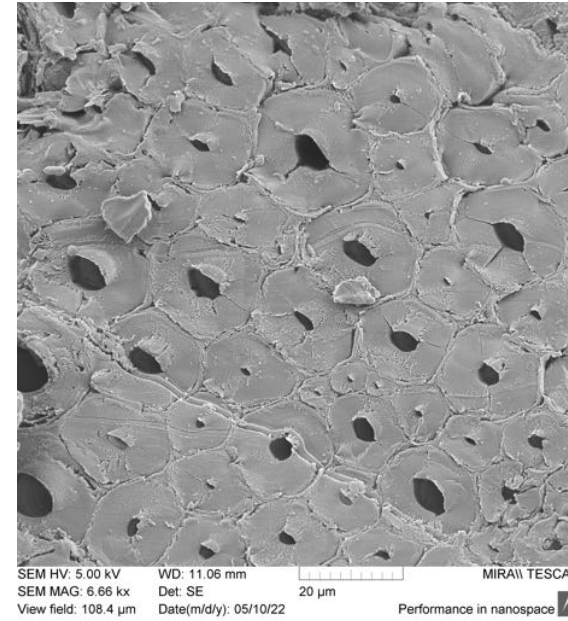
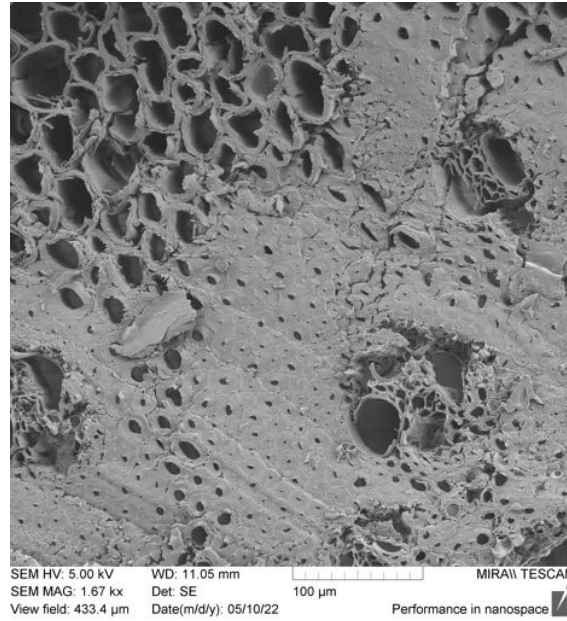
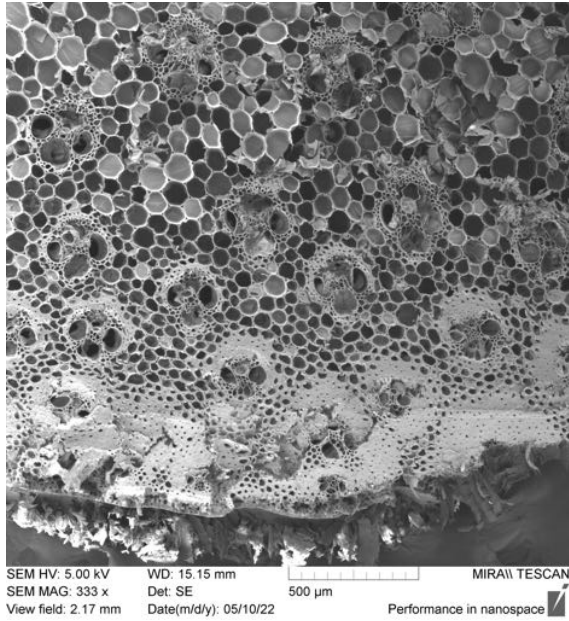
SEM HV: 5.00 kV WD: 11.75 mm
SEM MAG: 1.00 kx Det: SE
View field: 216.7 µm Date(m/d/y): 02/17/22
MIRA\ TESCAN
50 µm
Performance in nanospace



SEM HV: 5.00 kV WD: 11.93 mm
SEM MAG: 2.00 kx Det: SE
View field: 108.1 µm Date(m/d/y): 02/17/22
MIRA\ TESCAN
20 µm
Performance in nanospace

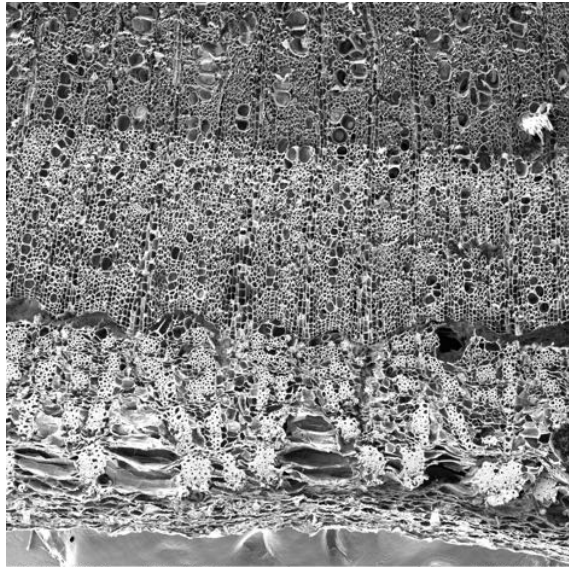
Karakterizacija izoliranih vlakana

Miskantus

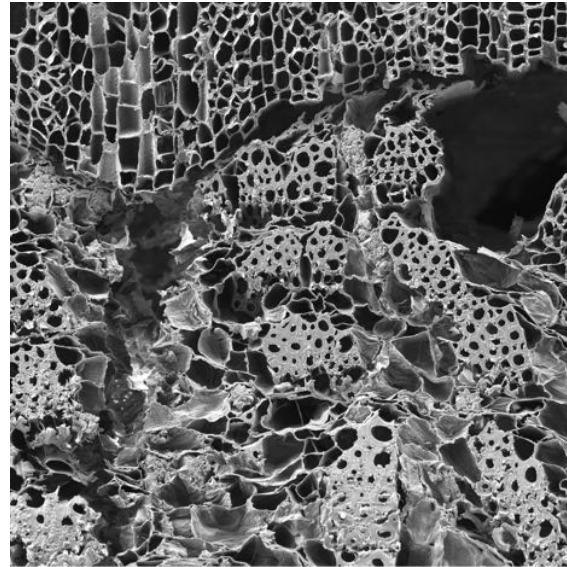


Karakterizacija izoliranih vlakana

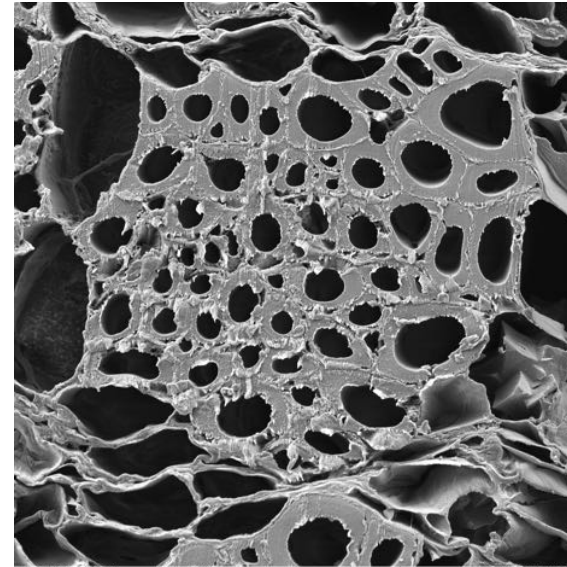
Virdžinijski sljez



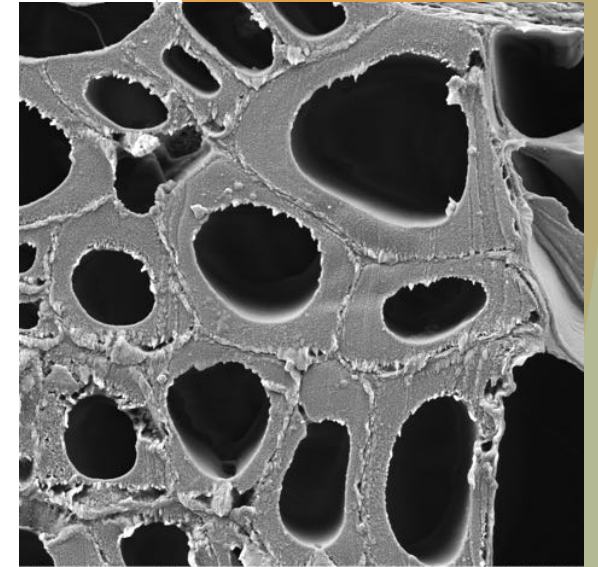
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View field: 2.17 mm Date(m/d/y): 05/11/22
MIRA\\ TESCAN
Performance in nanospace



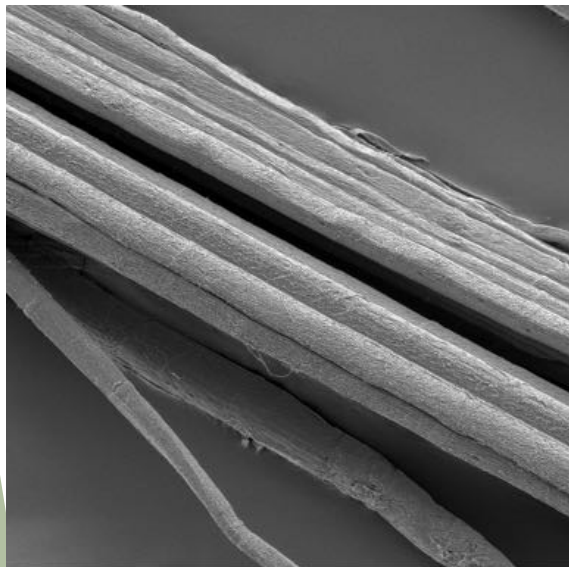
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View field: 433.4 µm Date(m/d/y): 05/11/22
MIRA\\ TESCAN
Performance in nanospace



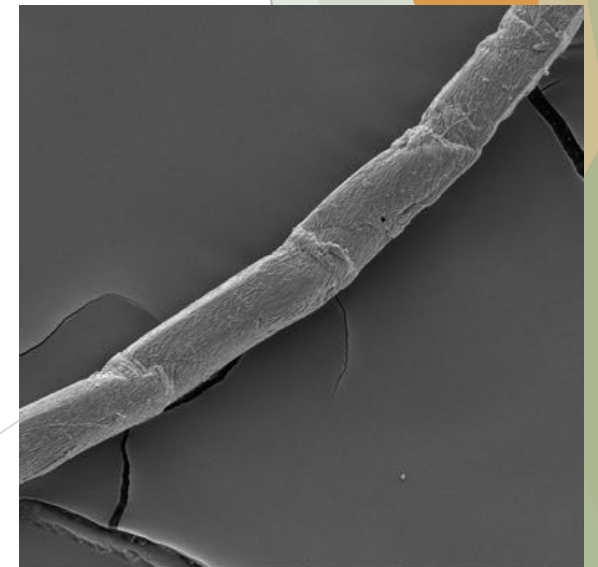
SEM HV: 5.00 kV WD: 9.886 mm
SEM MAG: 6.67 kx Det: SE
View field: 108.3 µm Date(m/d/y): 05/11/22
MIRA\\ TESCAN
Performance in nanospace



SEM HV: 5.00 kV WD: 9.880 mm
SEM MAG: 16.67 kx Det: SE
View field: 43.32 µm Date(m/d/y): 05/11/22
MIRA\\ TESCAN
Performance in nanospace



SEM HV: 5.00 kV WD: 11.96 mm
SEM MAG: 1.00 kx Det: SE
View field: 216.4 µm Date(m/d/y): 02/16/22
MIRA\\ TESCAN
Performance in nanospace



SEM HV: 5.00 kV WD: 11.90 mm
SEM MAG: 2.00 kx Det: SE
View field: 108.4 µm Date(m/d/y): 02/16/22
MIRA\\ TESCAN
Performance in nanospace

2. PATENT P20231398A, Datum prijave: 3.11.2023.

POSTUPAK PROIZVODNJE LIGNOCELULOZNIH VLAKANA IZ ENERGETSKIH KULTURA

IZUMITELJI: Sandra Bischof, Zorana Kovačević, Tajana Krička, Nikola Bilandžija



Jedna od namjena...

...ojačala u
kompozitnim
materijalima...