



UUDSED MATERJALID TURBAST - TALTECHI ARENDUSE ESIMESE ETAPI TULEMUSED

Estelle Silm, PhD

Keemia ja Biotehnoloogia Instituut
Tallinna Tehnikaülikool

Leeli Amon, PhD

Geoloogia Instituut
Tallinna Tehnikaülikool

06.11.2025

AASTA TAGASI TURBALIIDU SEMINARIL: TURBA VÄHEMTEADA OMADUSED JA VÕIMALUSED KÕRGE LISANDVÄÄRTUSEGA TOODETE TOORMENA

- Aastane TalTech Arendusgrant (L. Amon, K. Kaldas, E. Silm, B. Mets, Y. Karpichev, M. Mohan, A. Mikhraliieva)
- **Idee:**
- leida turbakeemia rakendused, mis:
 - Leiaks kõrge lisandväärtusega kasutusvõimaluse vähemkasutatud materjalile
 - Pakuks reaalselt innovatsiooni
 - Järgiks "roheline keemia" ning keskkonnahoiu suundi



ARENDUSGRANT

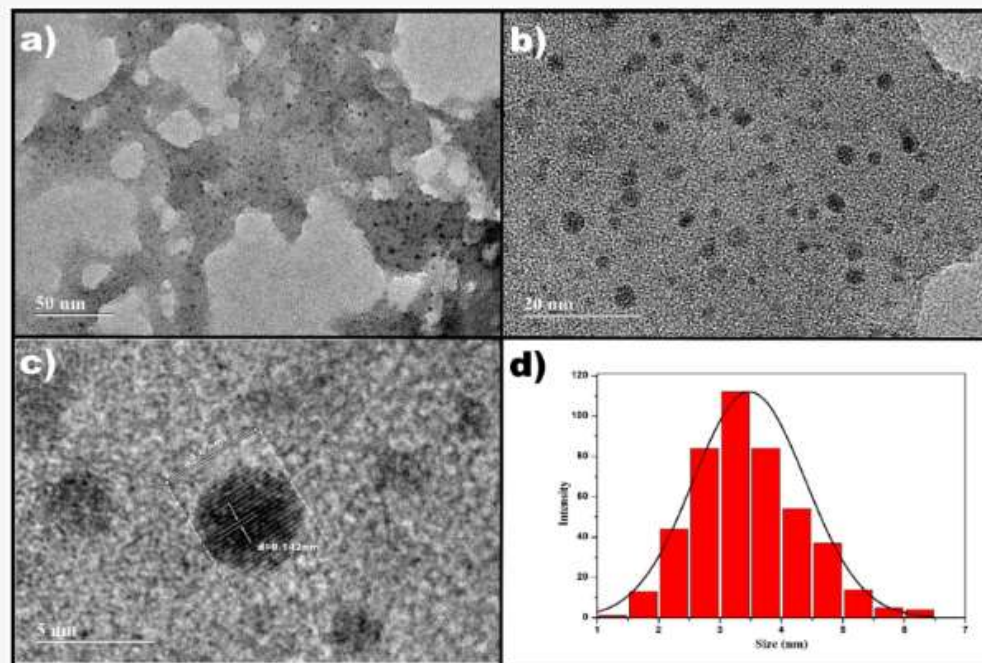
- Koostöö Tootsi Turbaga
- Koodid:
 - Black – hästilagunenud turvas
 - Cotton grass & fiber – tupp-villpeaturvas
- Aasta jooksul toimus pidev laboritöö ja arendustegevus
- Lisaks online koosolek Neova arendustiimiga, Tallinna Veepuhastusjaama külastus ning võimalike *start-up* sponsorite otsing



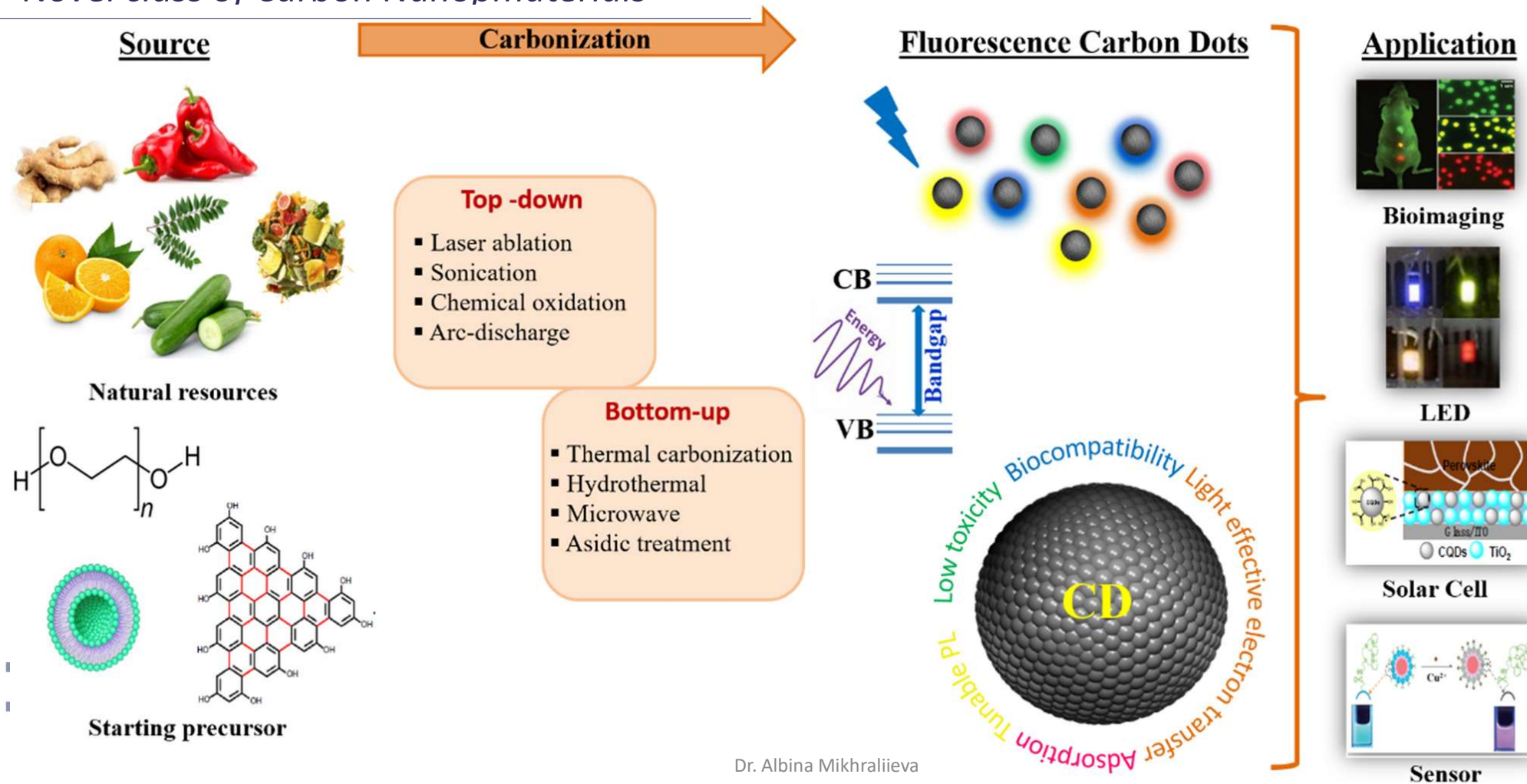
SUUND 1: NANOMATERJALID

- Materjal avastati 2004. aastal
- Metoodika Brasiiliast
- Materials 2018, 11(9), 1492: <https://doi.org/10.3390/ma11091492>
- Arenevad kasutusvaldkonnad:
 - Korrosioonikaitse
 - Pindade UV-kaitse titaanoksiidi asemel
 - Päikesepaneelide pinnakate
 - Biomeditsiin, diagnostika, *bio-imaging*, ravimite kanne
 - Sensorid, elektroonika
 - Tulevikus ka energia ülekande-akudes (*super-capacitor*)

Figure 12. High-resolution transmission electron microscopy. (a) Carbon nanoparticles at the scale of 50 nm. (b) Carbon nanoparticles at the scale of 20 nm. (c) Carbon nanoparticles with approximate diameter of 4.6 nm and highlight of the interatomic distance of 0.142 nm on a 5 nm scale. (d) Distribution of the average sizes of CQDs, with average size of 3.5 nm.

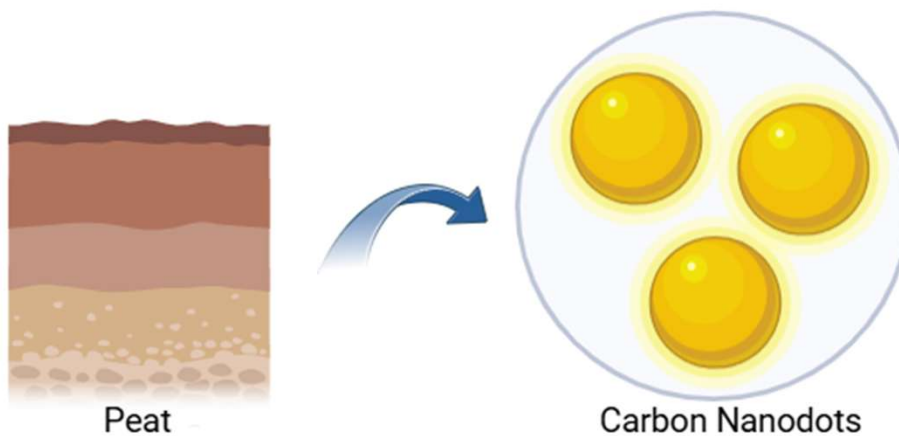


Novel class of Carbon Nanopmaterials



Dr. Albina Mikhralieva

Transformation of peat into innovative nanomaterial



Benefits

- Nanosize objects
- Biocompatibility
- Increased reactivity
- Low cytotoxicity
- Antibacterial properties
- Enhanced UV-blocking effect
- Presence of Photoluminescence

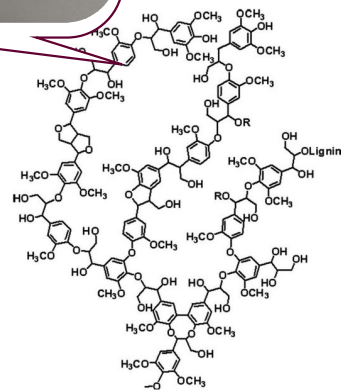
Problems

- How is it done?
- How to isolate it from complex byproducts?
- How to study it?
- How to prove it?

Preliminary study



It is reported that peat soil is an excellent raw material for the preparation of carbonaceous materials



water, 180 degree, 8h



Organosolv lignin
(by Dr.Mahendra M.)

Separation – crucial step



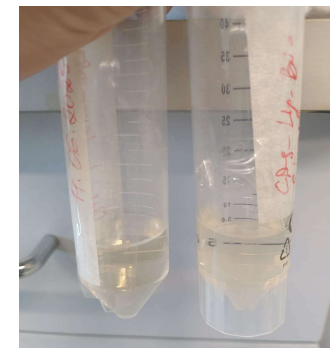
Centrifugation
10000 rpm



Filtration 0.22microm



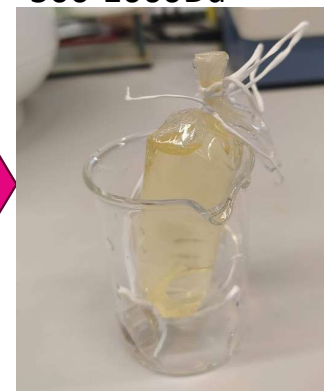
Evaporation
of the solvent



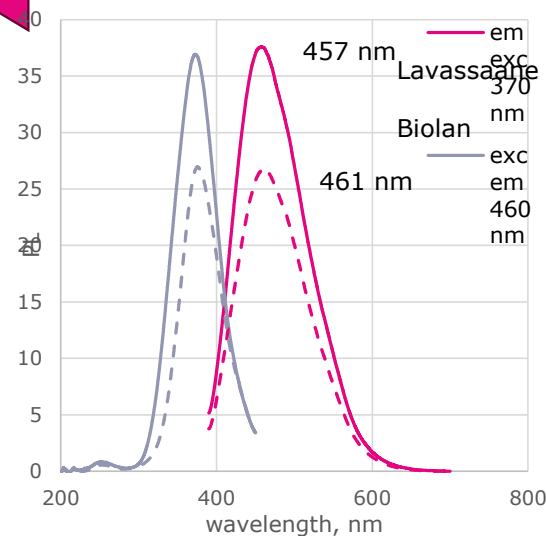
Re-dispersion



Dialysis
500-1000Da

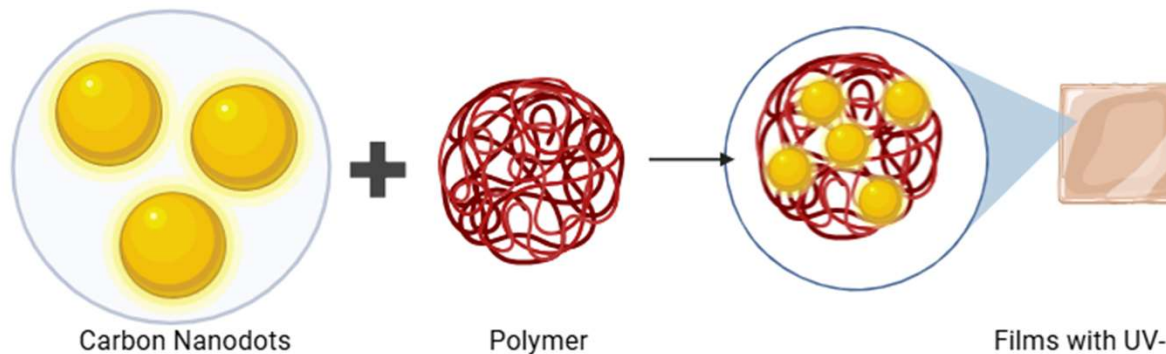


Dr. Albina Mikhralieva



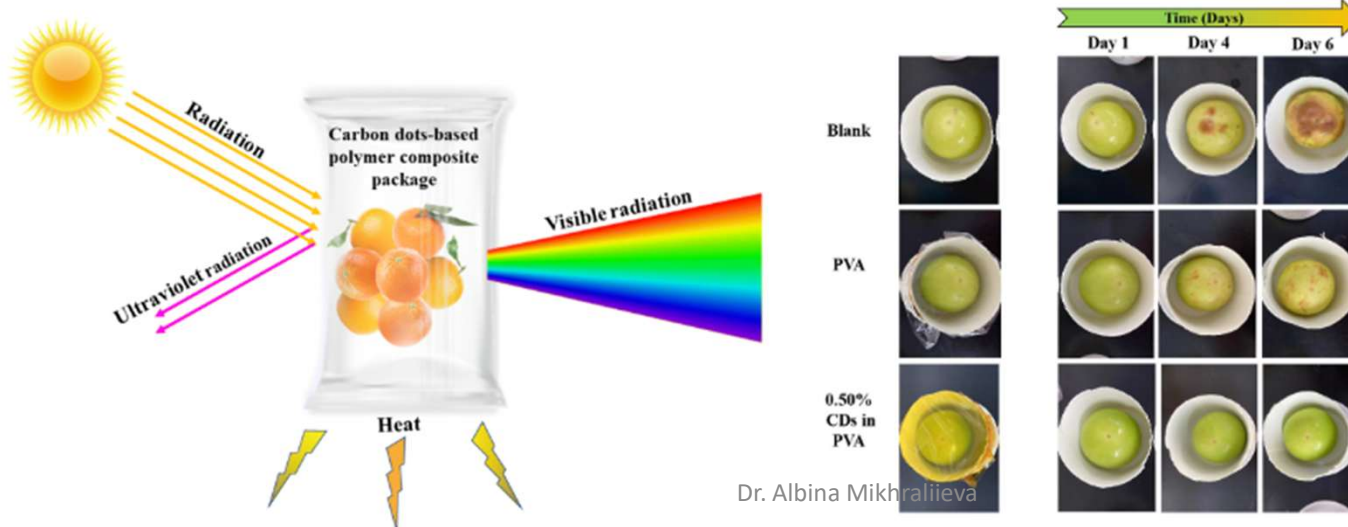
Preparation of smart packaging

Combination with degradable polymer



Films with UV-blocking properties

Creating Peat-derivative Carbon dots-based composite food packaging



Dr. Albina Mikhralieva

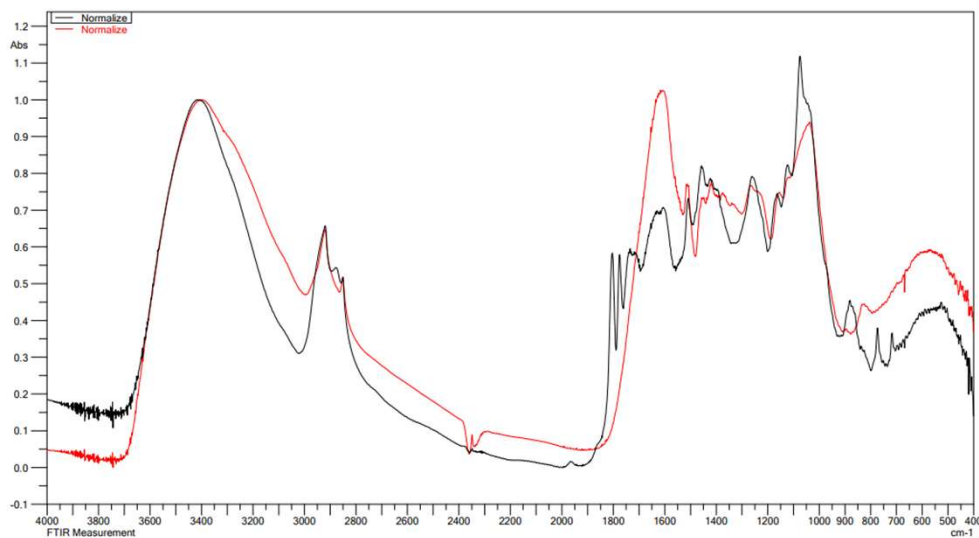
<https://doi.org/10.1021/acsami.2c10869>

SUUND 2: BIOPOLÜMEERID ELEMENTANALÜÜS

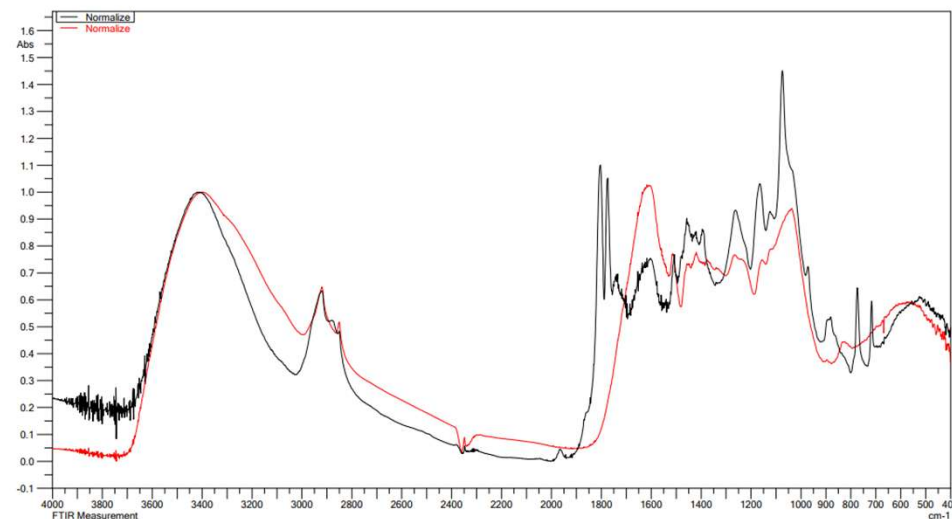
Lähteaine	Proov	C % average	H% average	N% average	O% calculated	H/C	O/C
	Field 11 black	50.75	5.75	2.31	41.19	1.36	0.61
	Cotton grass	50.84	6.08	0.94	41.75	1.44	0.62
	Biolan Fiber	48.45	6.04	0.6	45.47	1.5	0.7
Field 11 black	ES-172 ^a	49.02	5.92	1.27	43.79	1.45	0.67
	ES-199 ^a	51.38	5.61	1.36	41.65	1.31	0.61
	ES-202 ^b	50.58	5.41	1.27	42.74	1.28	0.63
	ES-220 ^c	52.57	5.51	1.76	40.16	1.26	0.57
	ES-222 ^d	52.79	6.26	0.78	40.17	1.42	0.57
Cotton grass	ES-184 ^e	53.02	6.09	-	40.89	1.38	0.58
Biolan Fiber	ES-216 ^f	50.07	5.98	-	43.95	1.43	0.66

^aReaktsioon Parr reaktoris, 175 °C; ^breaktsioon kolvis, 175 °C; ^creaktsioon kolvis, 200 °C; ^dreaktsioon kolvis, 150 °C; ^ereaktsioon Parr reaktoris; ^freaktsioon kolvis.

FTIR



Pilt 1 Field 11 black (punane) ja modifitseeritud turba ES-199 (must) võrdlus



Pilt 2 Field 11 black (punane) ja modifitseeritud turba ES-202 (must) võrdlus

TURVAS JA MODIFITSEERITUD TURVAS – POORI SUURUS; BET-ANALÜÜS

Proov	BET pindala	Langmuir pindala
Field 11 black	2.1 m ² /g	2.95 m ² /g
ES-172	1.59 m ² /g	2.22 m ² /g
Cotton grass	1.64 m ² /g	2.42 m ² /g
ES-184	2.1 m ² /g	2.95 m ² /g
Biolan Fiber	2.02 m ² /g	3.14 m ² /g
ES-216	2.94 m ² /g	4.13 m ² /g

Selected Materials with High Surface Areas		
Typical surface area (m ² /g)	Material	Application
7140	Metal–organic framework ^[9]	gas absorption
900	Faujasite ^[10]	catalyst
500–3000	activated carbon	gas and solute absorption
200	alumina ^[11]	catalyst support

Wikipedia: Specific surface area

Table 1
Surface areas and textural properties of the peat-derived ACs.

AC precursor	Activation agent	BET ^a (m ² /g)	BJH cumulative desorption surface area (m ² /g)	Total pore volume ^b (cm ³ /g)	BJH cumulative desorption pore volume (cm ³ /g)	Average pore size (nm)
Raw peat	ZnCl ₂	700	180	0.36	0.13	2.08
	H ₃ PO ₄	680	380	0.50	0.42	2.97
Demineralized peat	ZnCl ₂	890	340	0.48	0.24	2.16
	H ₃ PO ₄	770	430	0.51	0.38	2.66

^a Multi-point BET.

^b Total pore volume (less than 163 nm).

Materials Letters **2011**, 65, 744-747

Table 1
Specific surface area (S_{BET}), micropore volume (V_{micro}), mesopore volume (V_{meso}) and the average diameters (D_p) of the five adsorbents.

Adsorbent	S_{BET} (m ² /g)	V_{micro} (cm ³ /g)	V_{meso} (cm ³ /g)	D_p (nm)
F400	793	0.363	0.123	2.44
Bone char	107	0	0.255	9.43
Peat	0.7	0	0.001	5.52
BACX2	2123	0.494	0.943	2.79
BACX6	1400	0.209	2.008	5.32

Journal of Colloid and Interface Science
2009, 337, 32-38

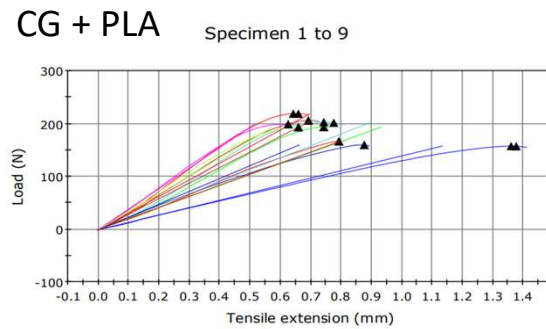
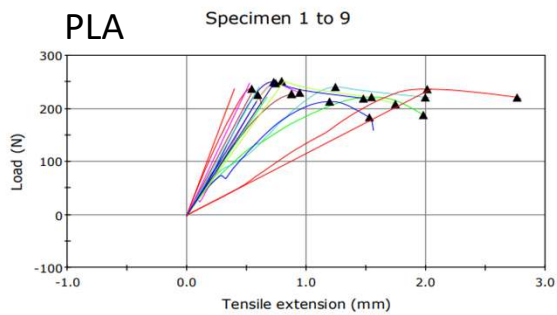
TURBA NING MODIFITSEERITUD TURBA JA PLA (*POLYLACTIC ACID*) SEGU

- Field 11 black + PLA ja modifitseeritud turvas + PLA filamendid olid natukene kleepuvad
- Kleepuvuse tõttu ei saadud nendest filamentidest teha standardseid vorme, et mõõta tugevust
- Cotton-grass + PLA seguga õnnestus teha standardvormid



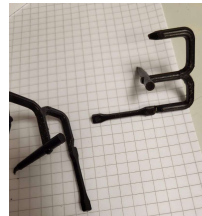
TÕMBETUGEVUS (*TENSILE STRENGTH*)

Proov	Max load, N	Tensile stress at max load, Mpa	Tensile extension at max load, mm	Load at break, N	Tensile stress at break, Mpa	Tensile extension at break, mm	Modulus of elasticity
PLA	231,14	55,16	1,14	210,4	50,20	1,59	1283,23
Cotton grass + PLA	186,12	46,15	0,78	185,97	46,12	0,79	1041,43



**TAL
TECH**

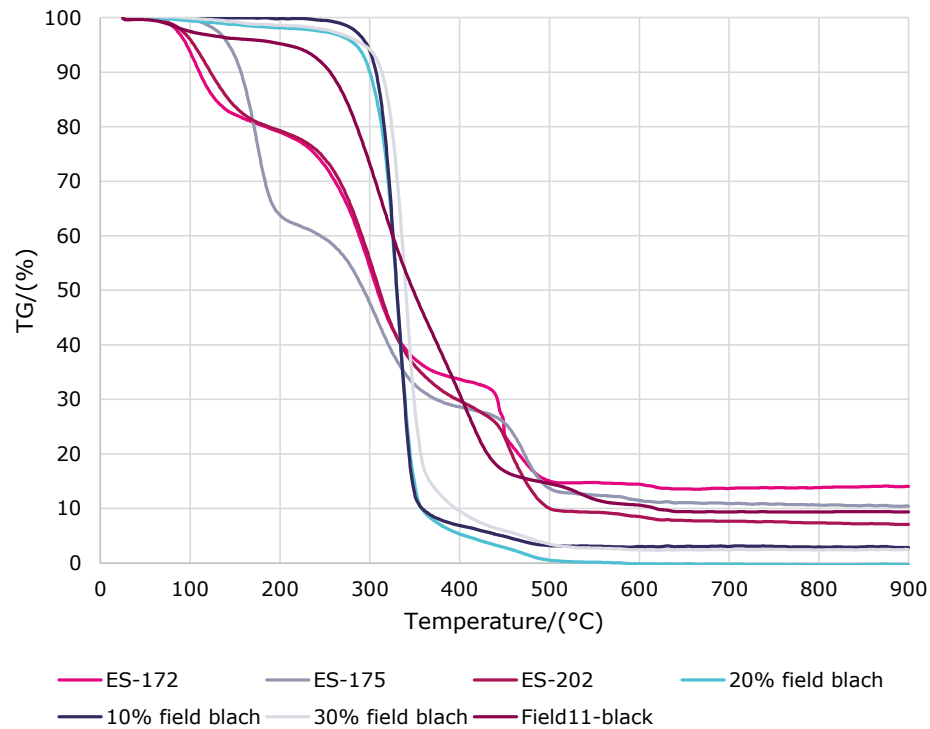
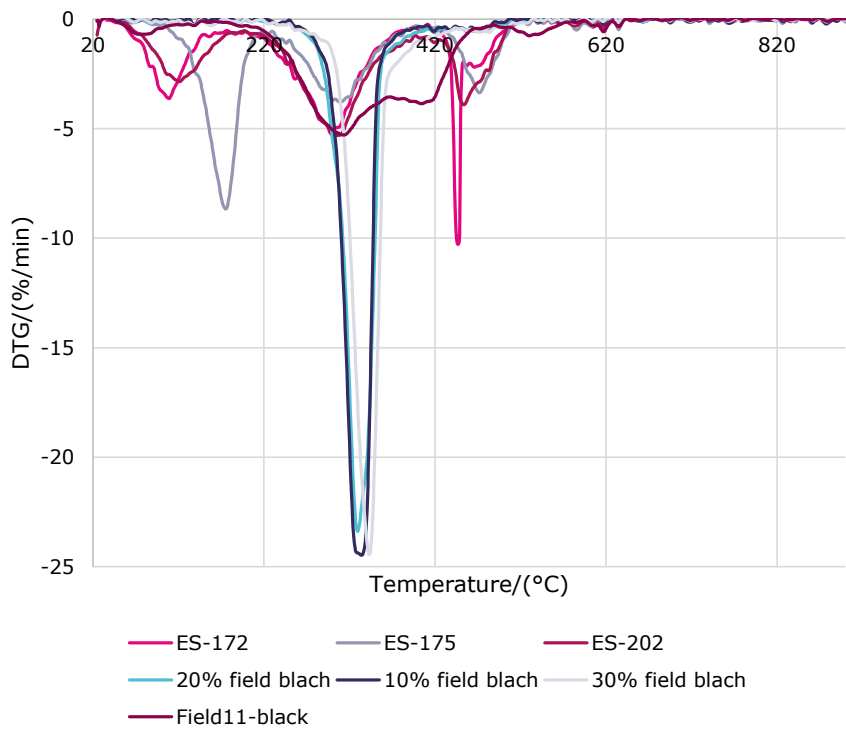
TALLINNA TEHNIKAÜLIKOOL



10 % CG + PLA



TGA, DSC



MIS EDASI...

- Laboriarendus
 - Ärisuuna arendus: mentor, majandusarvutused
 - Tootestamine
 - Patendid
-
- ASTRA+
 - Koostöö ettevõtetega



**TAL
TECH**

KÕIK ARVAMUSED TERETULNUD!

19.11.2025