

# SEM KARAKTERIZACIJA KERATINSKIH VLAKANA



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Textile Science Research Center

<http://www.ts-rc.eu>



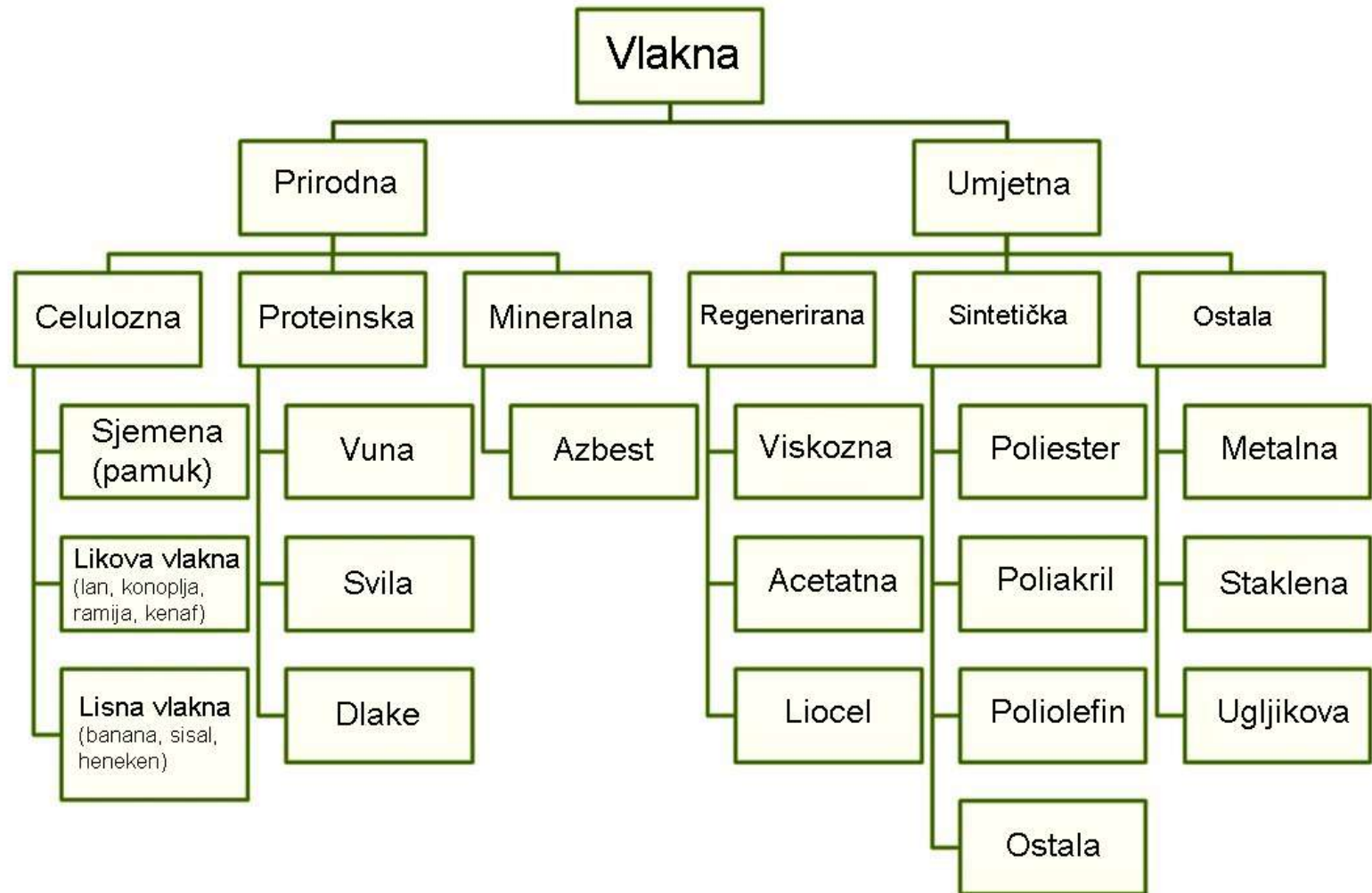
# FE-SEM, MIRA I ILMU, TESCOAN

- 2009. god. U sklopu EU projekta FP7-REGPOT-2008: T-Pot nabavljen FE-SEM, Mira, Tescan.
- Do tada se kao izvor elektrona koristio Wolfram ili LaB6 (lantan heksaborid).
- FE omogućava bržu izradu i kvalitetnije SEM slike.



# TEKSTILNA VLAKNA

- Vlakno je izduženi oblik materije u kojem je odnos debljine prema duljini minimalno 1:100.



# KERATIN

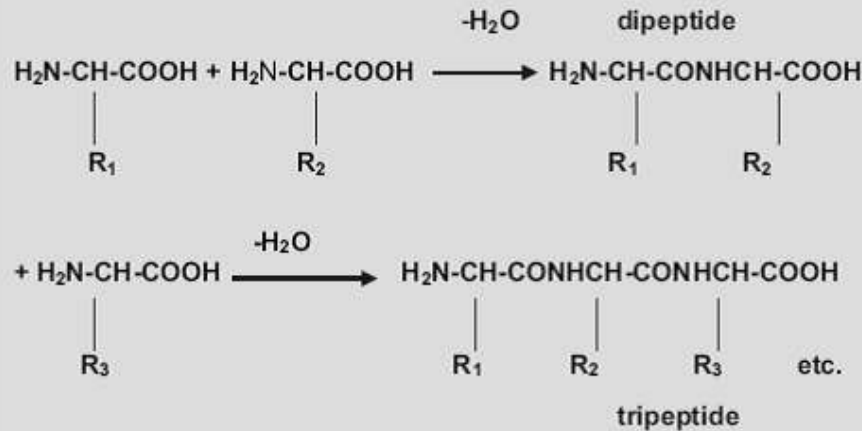
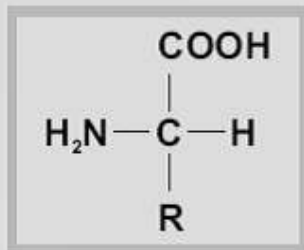


Figure 1: General Structure of an Amino Acid.

- Čvrsti, netopivi strukturni protein koji je građevna jedinica dlake, vune, rogova, noktiju, itd.

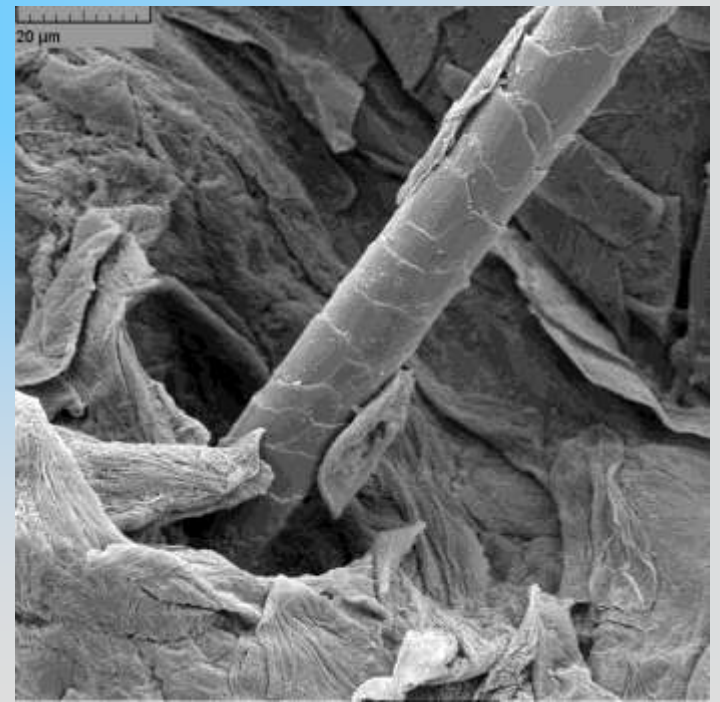
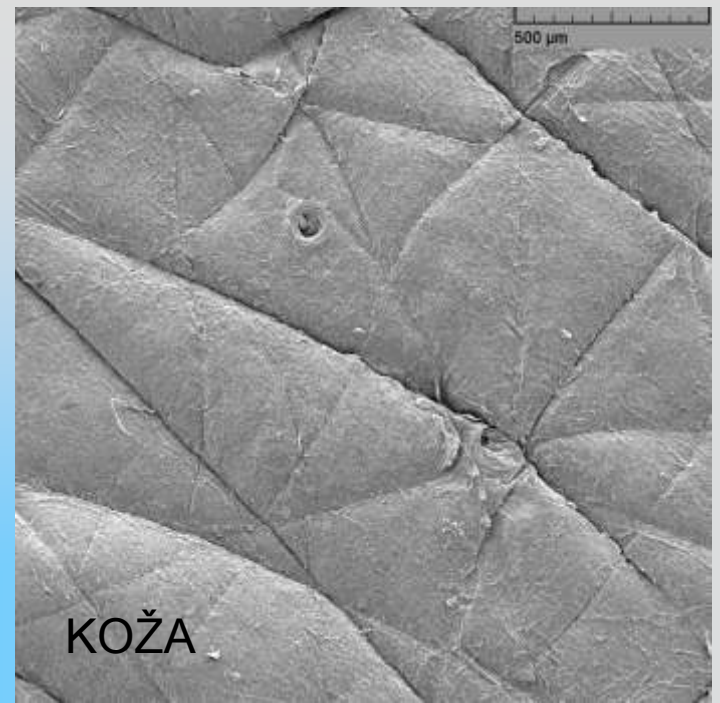


# KERATIN

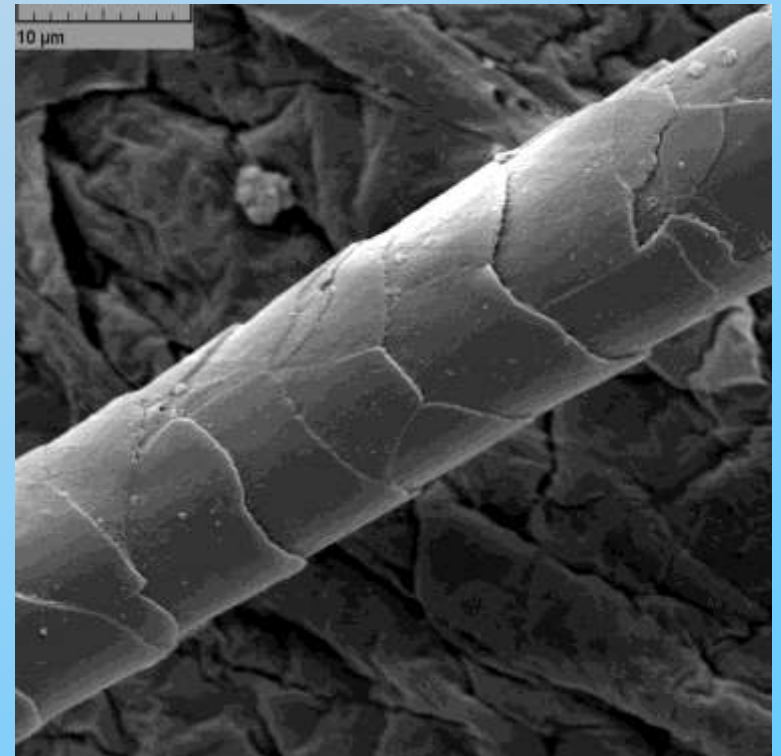
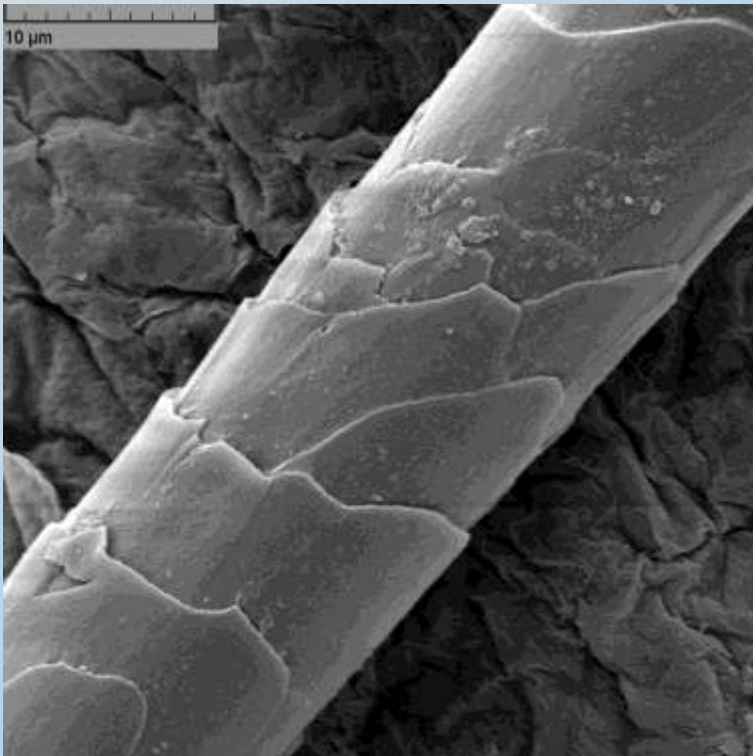
- Keratin je izgrađen od 20-ak različitih aminokiselina među kojima je i cistein – aminokiselina bogata sumporom.
- Što je više disulfidnih veza u keratinu to nastaju kruće tvorevine (kopita, rogovi...) odnosno ako je manja količina disulfidnih veza to nastaju mekše tvorevine poput kože, dlaka, itd.



- Dlake su privjesak na koži koje rastu iz organa poznatog kao folikula.
- Scapus pili dio dlake koji viri iz kože - stabljika dlake.
- Stabljika dlake se sastoji od vanjskog sloja ili kutikule koja se sastoji od preklapajućih stanica koje tvore ljuske.



- Ljuske su građene od posebnih stanica koje su se keratinizirale.
- Ljuske ljudske kose se uvijek preklapaju dok životinje imaju široki raspon oblika ljusaka koji varira i duž dlake.
- Struktura kutikule je različita za svaku vrstu životinja.
- SEM važan instrument u razlikovanju životinjskih vrsta s obzirom na njihovu dlaku.



- Uspoređivanjem duljine, debljine i ostalih karakteristika ljuske može se zaključiti da li određene vrste mogu živjeti u istom okolišu.
- Što su ljuske uzdignutije to je svojstvo filcanja veće.
- Visina ljuske utječe na manji ili veći koeficijent trenja i time na osjećaj finoće vlakana.
- Što su izduljenije ljuske to je mekši opip.



**KERATINSKA VLAKNA**  
(vuna, životinjske dlake,  
strune, čekinje)

Deva, alpaka, ljama

Domaća koza

Angora koza

Angora kunić, kunić, zec

Svinja, konj, govedo

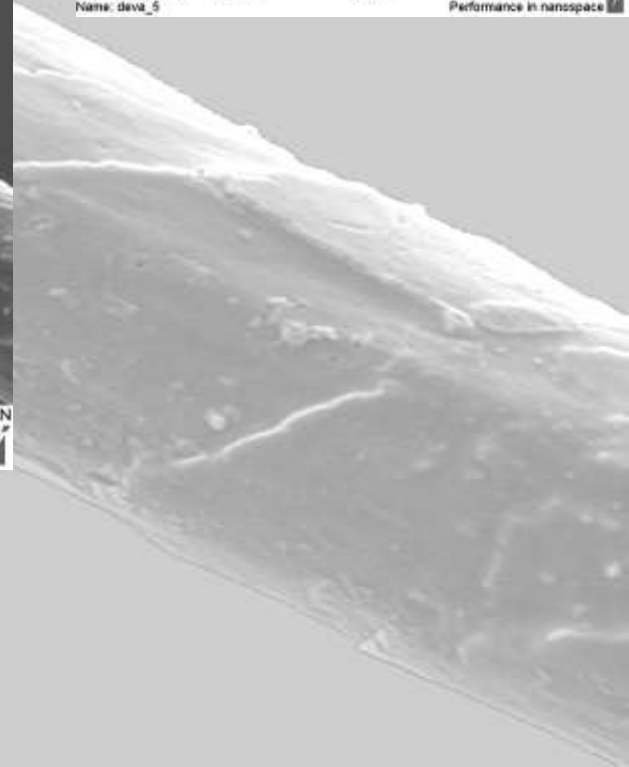
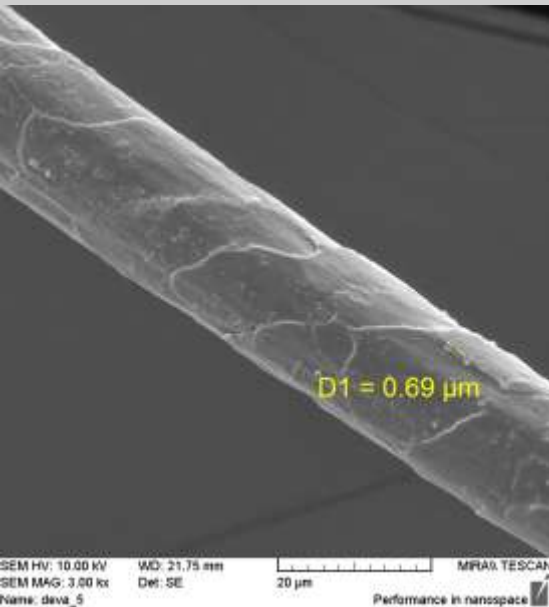
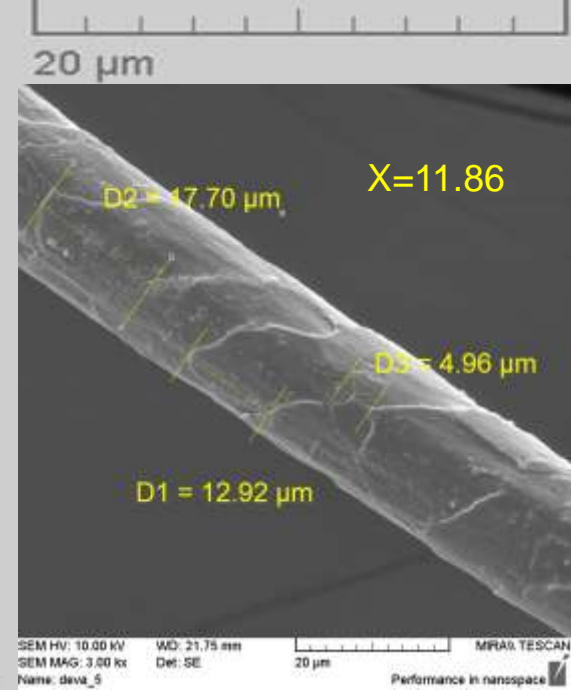
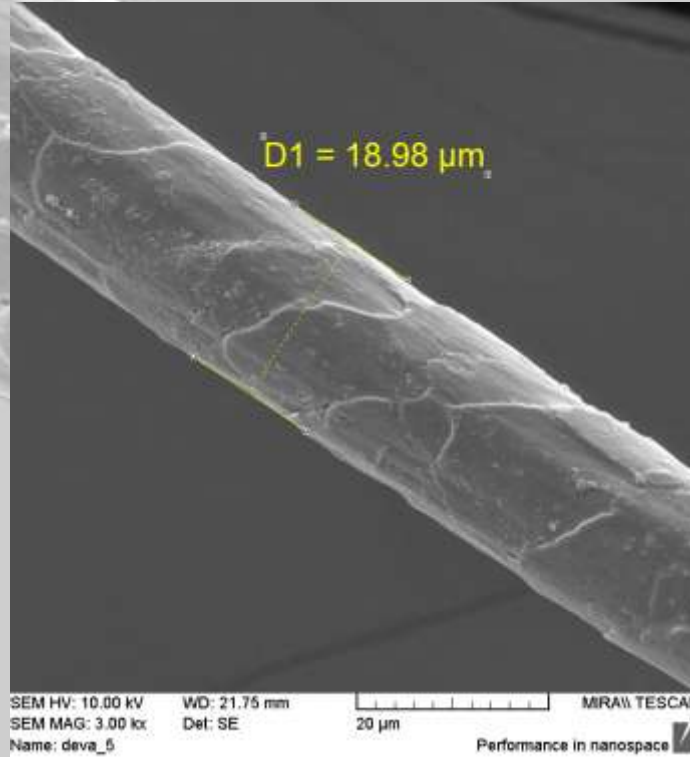
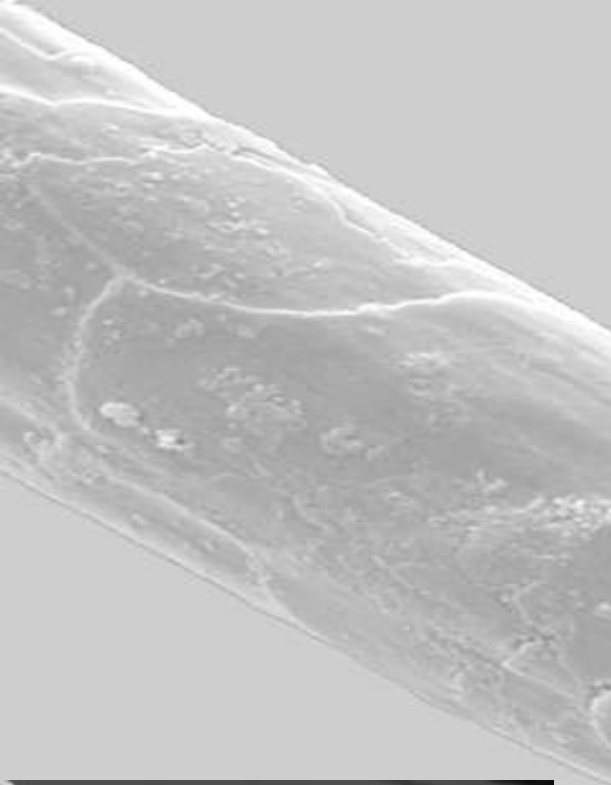
Jelen, sob

Dikobraz



**Deva**

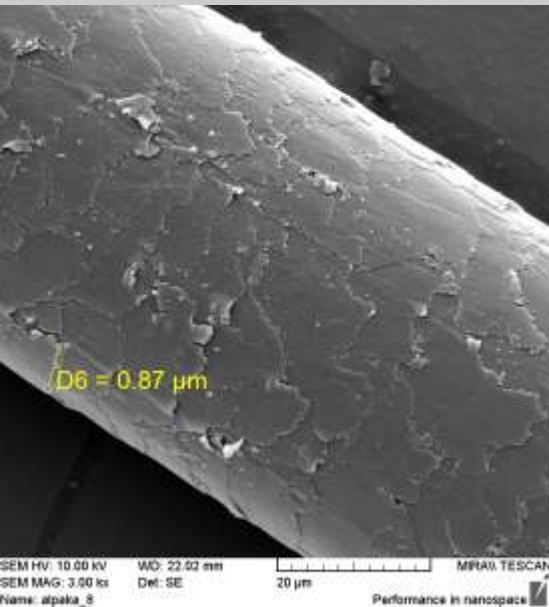
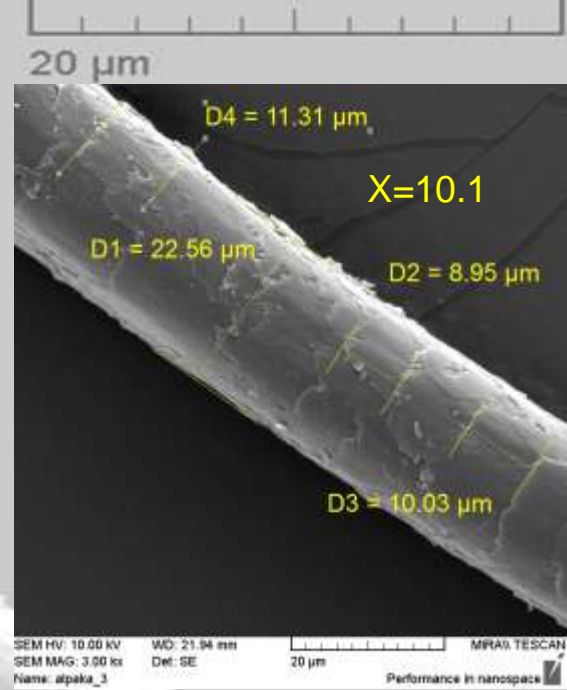
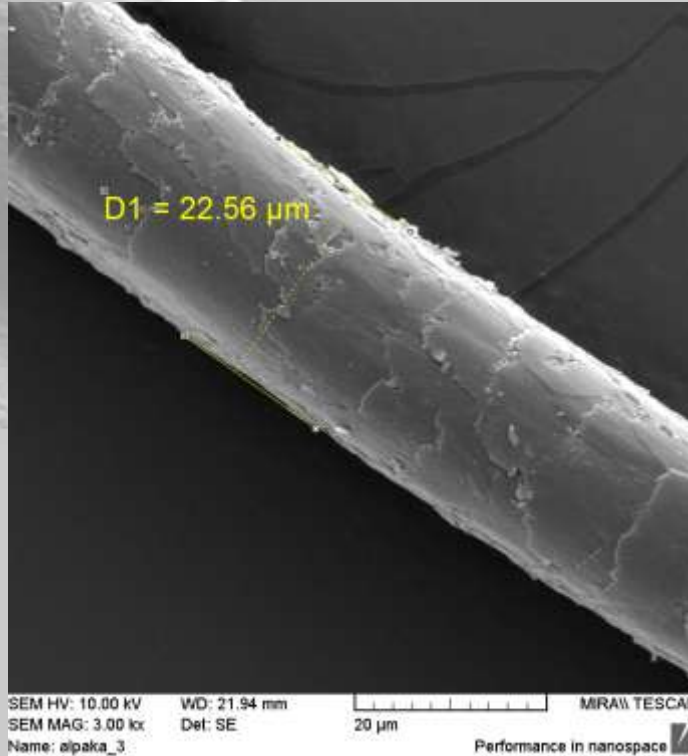
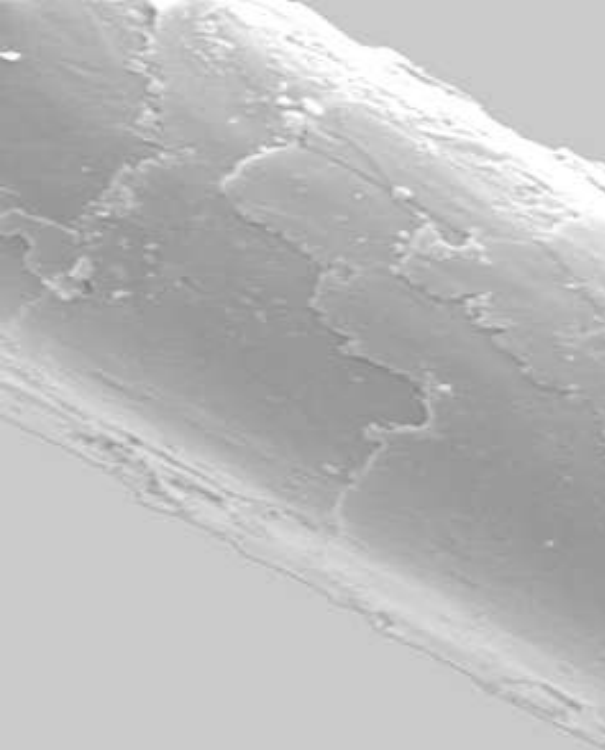
# DEVA





A

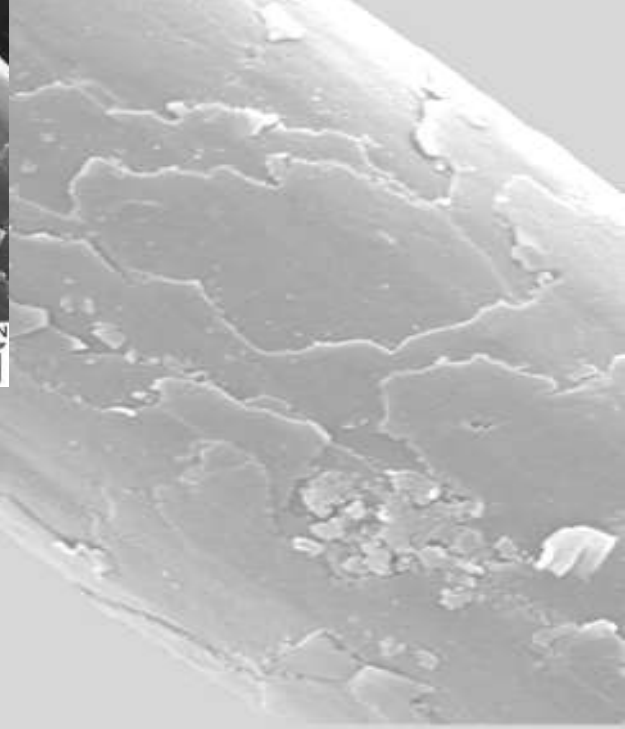
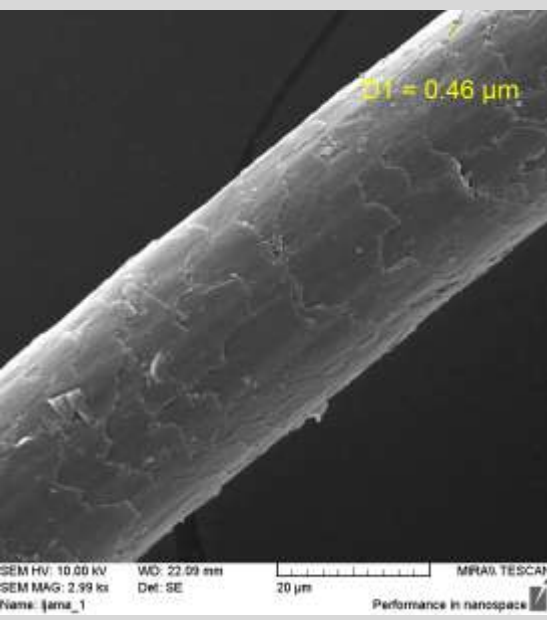
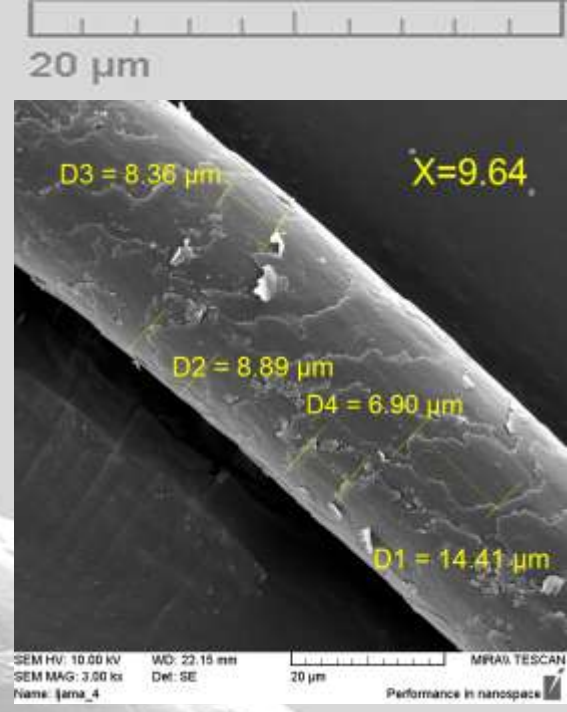
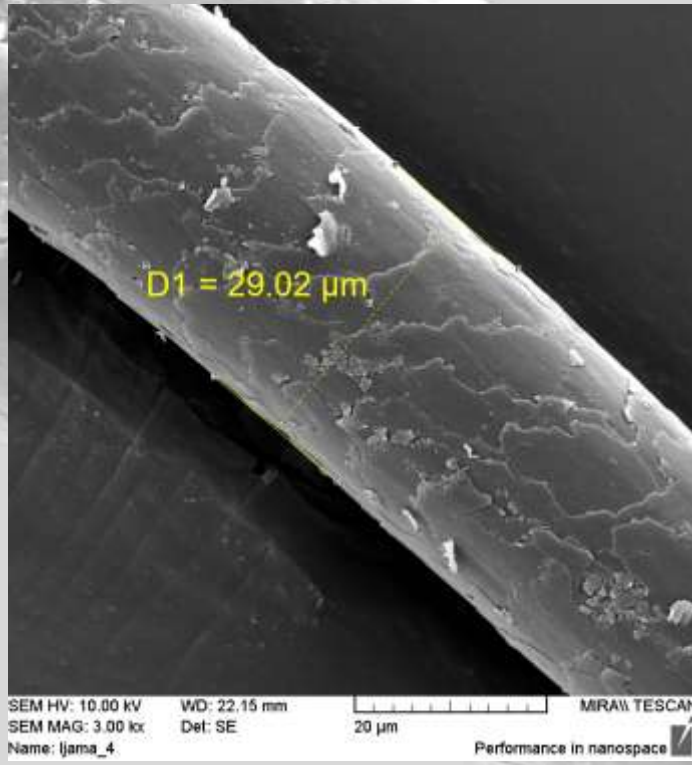
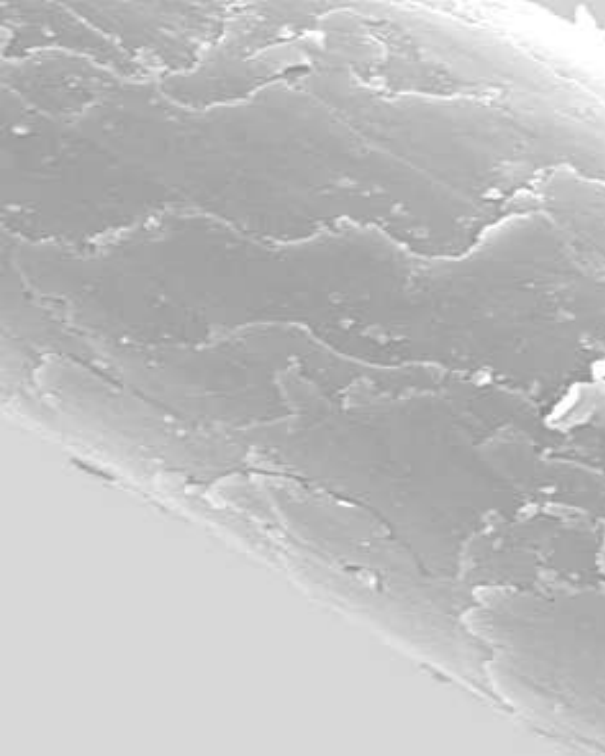
# ALPAKA

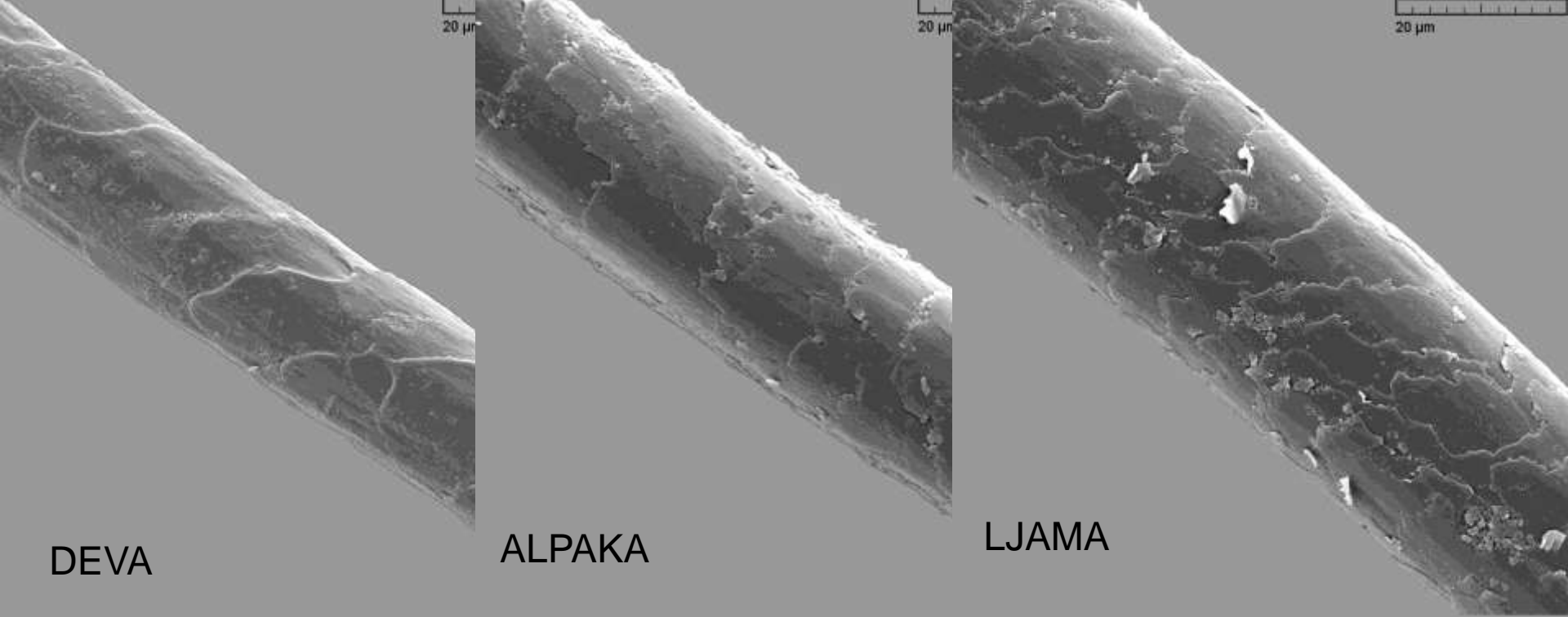


A photograph of a llama standing in a mountainous landscape. The llama is the central focus, with its head and neck clearly visible. It has a mix of brown and white wool. The background shows rugged mountains with patches of green grass and snow. The sky is blue with scattered white clouds. The image is framed by a white border with a ruler-like scale at the top. Large, bold, black text is overlaid on the bottom half of the image.

**Ljama**

# LJAMA





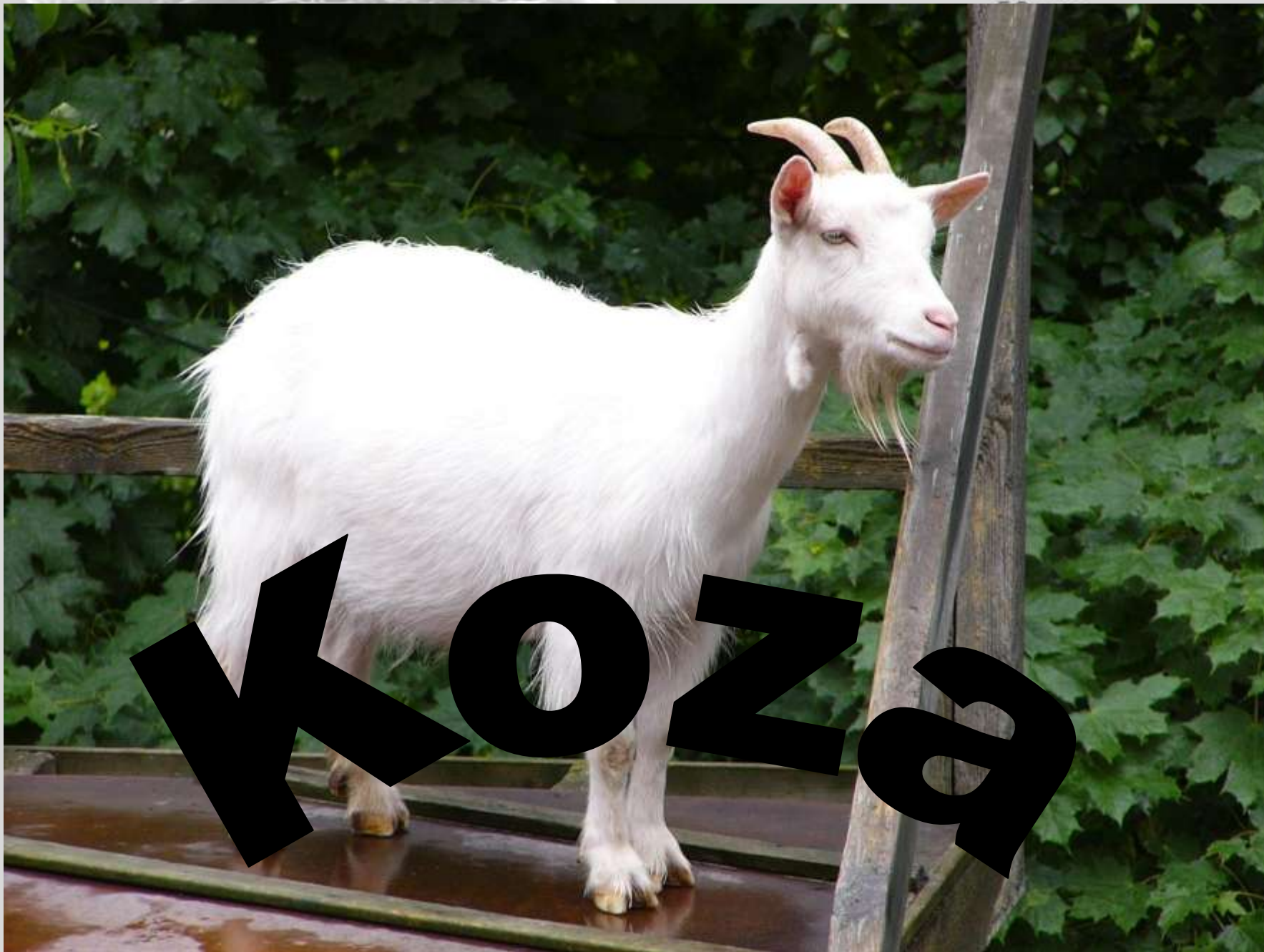
DEVA

ALPAKA

LJAMA

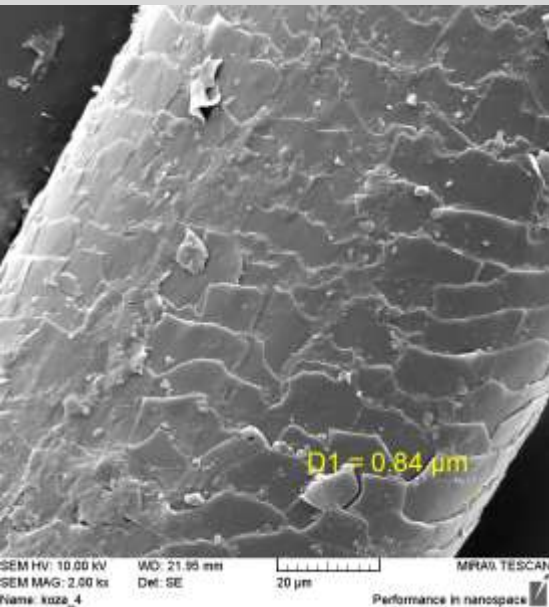
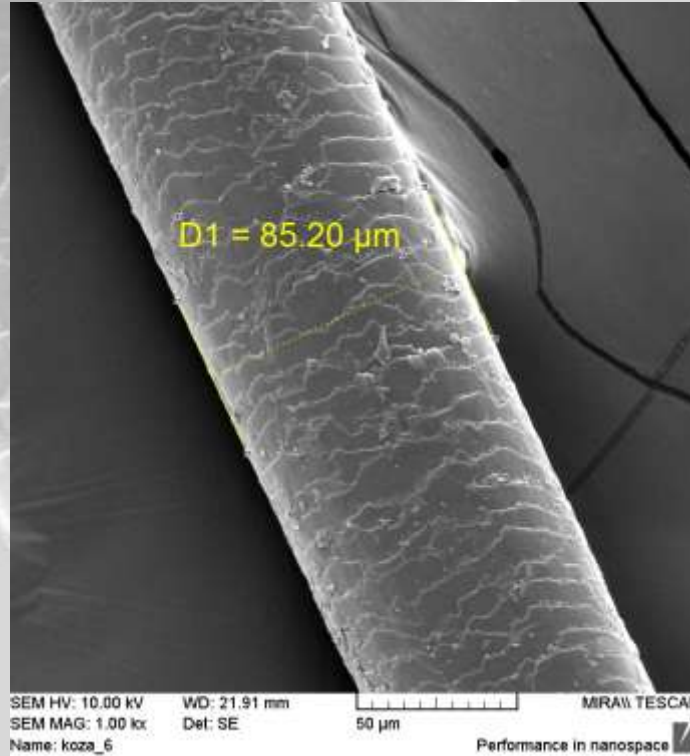
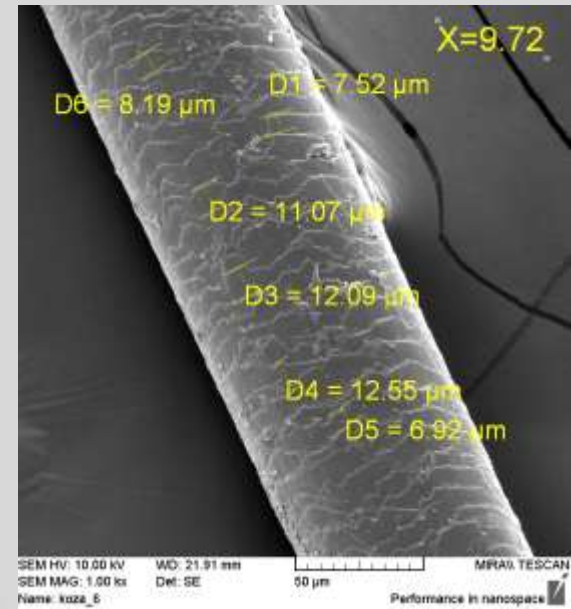
- Prstenaste ljuske – nataknute na vlakno, kao da je svaka gornja jednim svojim dijelom utaknuta u donju.
- Ovako građenu kutikulu imaju uglavnom fina vlakna (do 30 $\mu$ m).
- Sličnost alpakine i ljamine dlake dok devina dlaka pokazuje različitost.
- Prije SEM identifikacije uvijek treba definirati s kojeg dijela tijela životinje je uzeta dlaka.





# KOZA

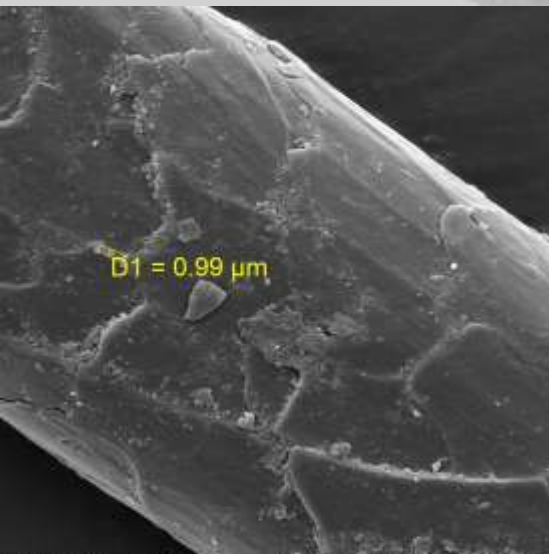
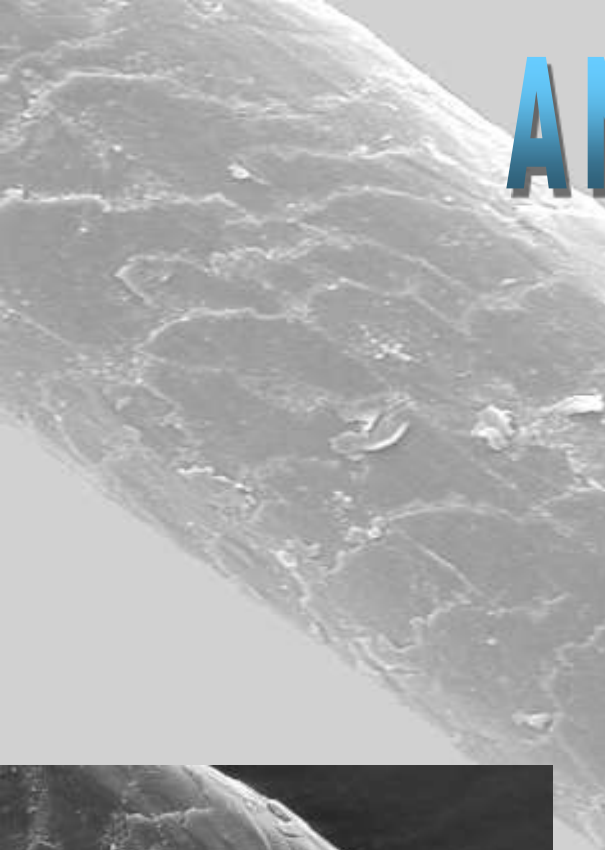
50  $\mu\text{m}$





**Angora koza**

# ANGORA KOZA

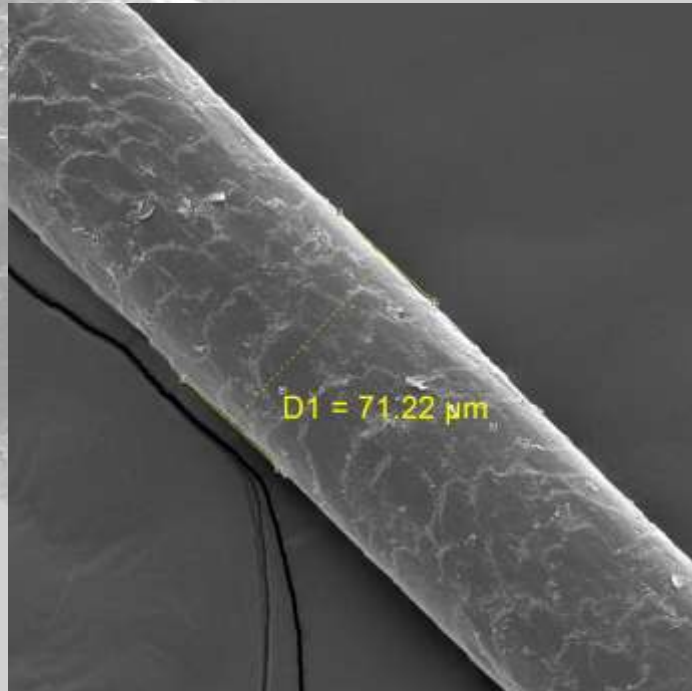


SEM HV: 10.00 kV  
SEM MAG: 3.00 kx  
Name: moher\_14

WD: 22.00 mm  
Del: SE

20  $\mu\text{m}$

MIRAII TESCAN  
Performance in nanospace

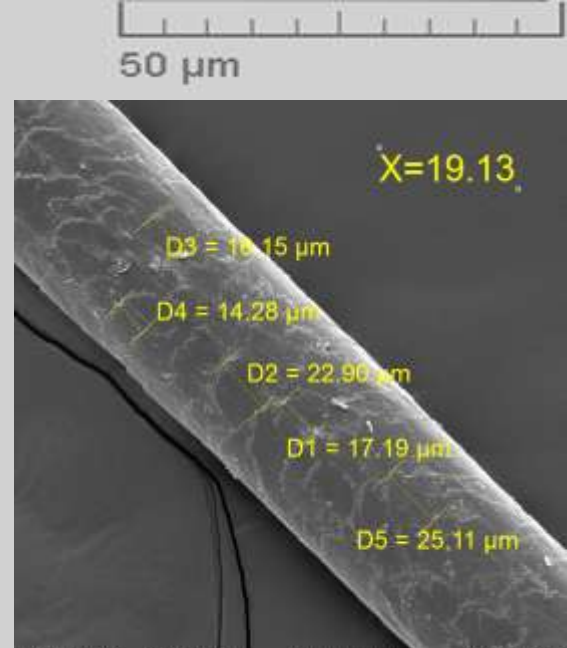


SEM HV: 10.00 kV  
SEM MAG: 1.00 kx  
Name: moher\_B

WD: 22.01 mm  
Del: SE

50  $\mu\text{m}$

MIRAII TESCAN  
Performance in nanospace

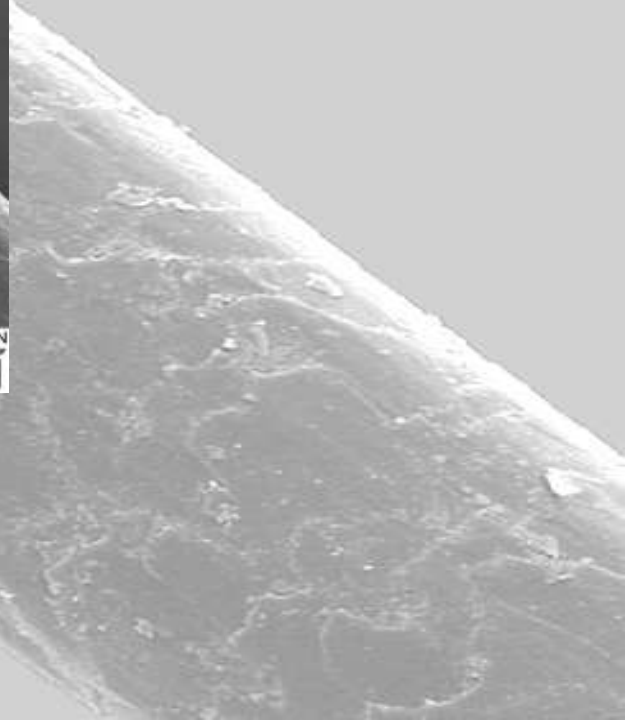


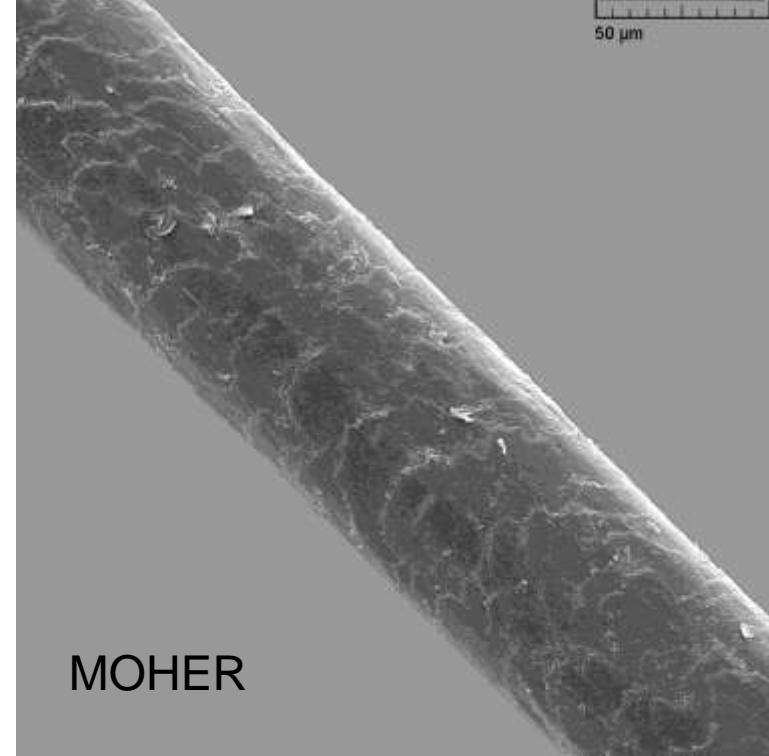
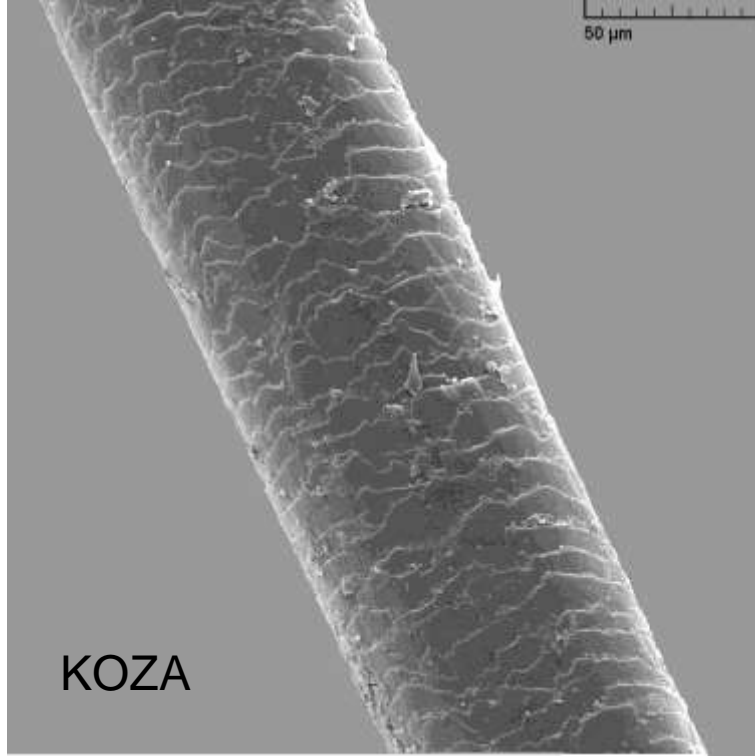
SEM HV: 10.00 kV  
SEM MAG: 1.00 kx  
Name: moher\_8

WD: 22.01 mm  
Del: SE

50  $\mu\text{m}$

MIRAII TESCAN  
Performance in nanospace





- Gruba vlakna koja nemaju dobra svojstva pa se više koriste za postizanje efekta.
- Ljuske mohera se slabo vide, gusto su složene jedna pored druge i gotovo se ne preklapaju.
- Duge ljuske su uzrok glatkoće i visokog sjaja vlakna.
- Na velikoj neprekinutoj površini vlakna svjetlosne zrake se jako odbijaju.



**Angora kunić**

# ANGORA KUNIĆ

20  $\mu\text{m}$

X=10.17

D3 = 9.37  $\mu\text{m}$

D1 = 10.06  $\mu\text{m}$

D2 = 11.07  $\mu\text{m}$

SEM HV: 10.00 kV WD: 22.02 mm MIRA\\ TESCAN  
SEM MAG: 3.00 kx Det: SE 20  $\mu\text{m}$   
Name: angora\_kunic\_2 Performance in nanospace

D1 = 7.47  $\mu\text{m}$

SEM HV: 10.00 kV WD: 22.02 mm MIRA\\ TESCAN  
SEM MAG: 3.00 kx Det: SE 20  $\mu\text{m}$   
Name: angora\_kunic\_2 Performance in nanospace

D1 = 0.57  $\mu\text{m}$

SEM HV: 10.00 kV WD: 22.02 mm MIRA\\ TESCAN  
SEM MAG: 3.00 kx Det: SE 20  $\mu\text{m}$   
Name: angora\_kunic\_2 Performance in nanospace

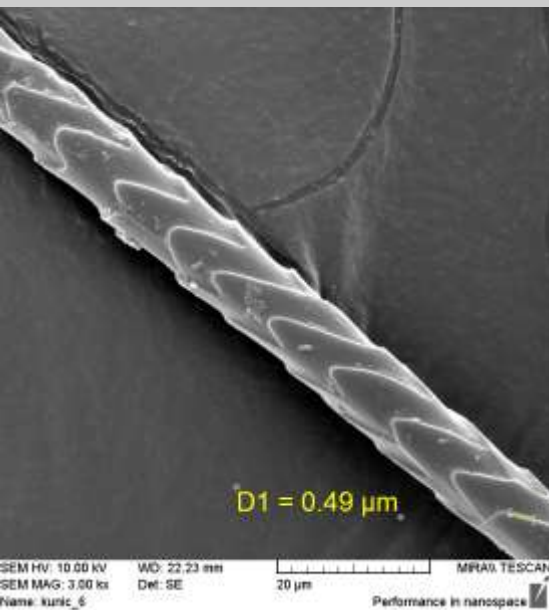
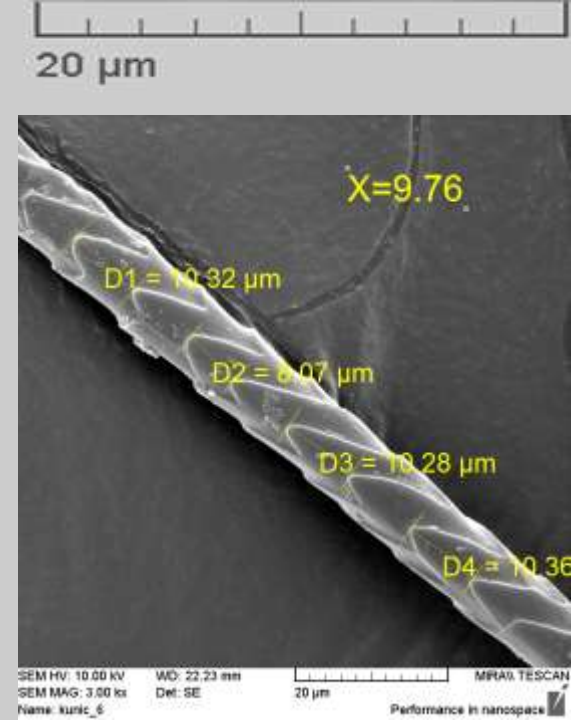
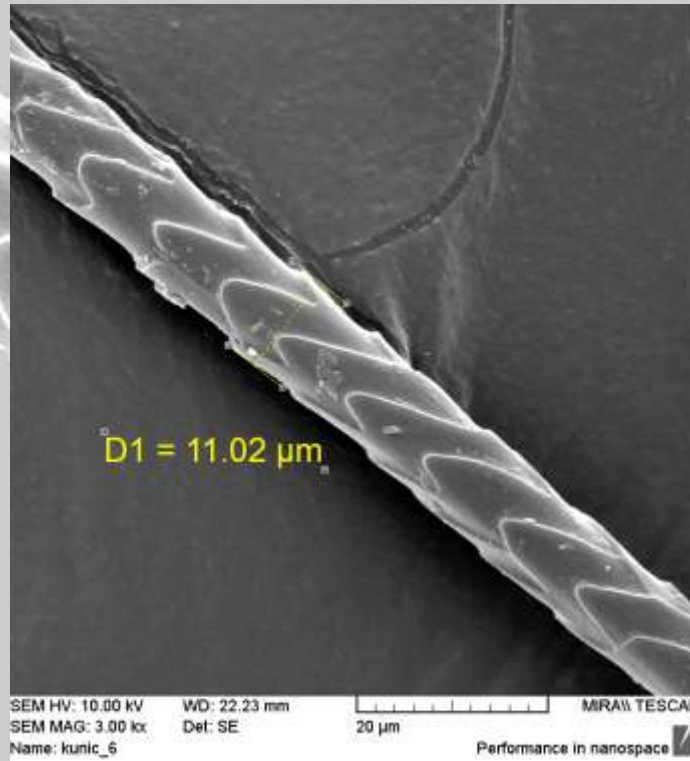
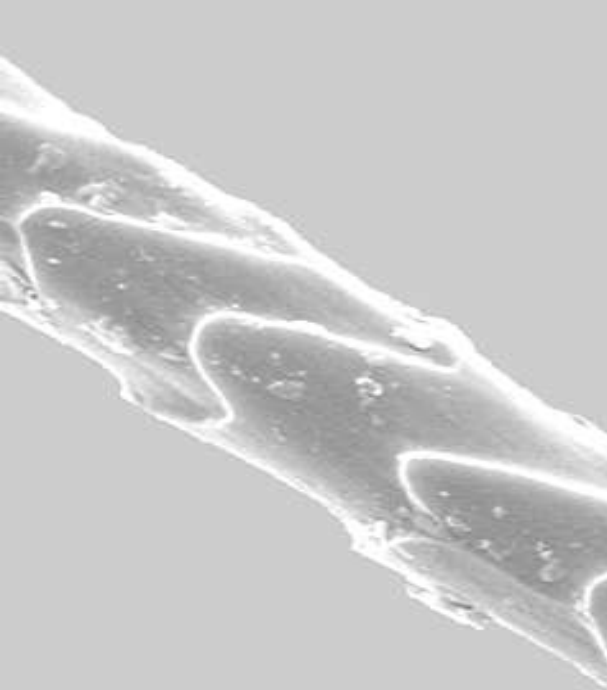
20  $\mu\text{m}$



**Kunic**



# KUNIĆ

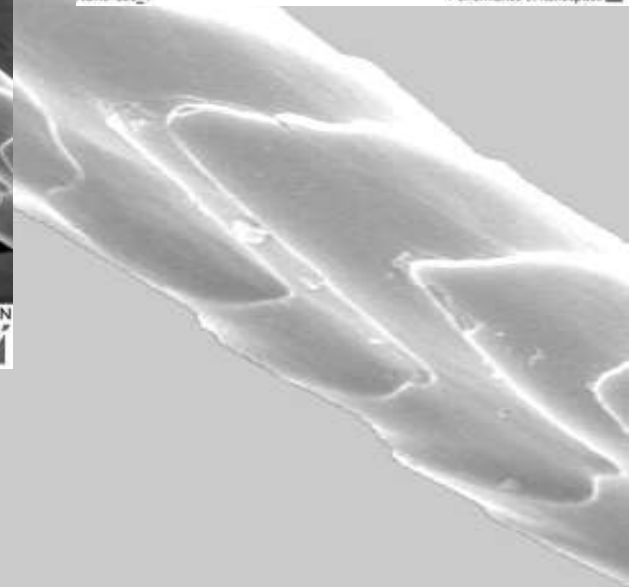
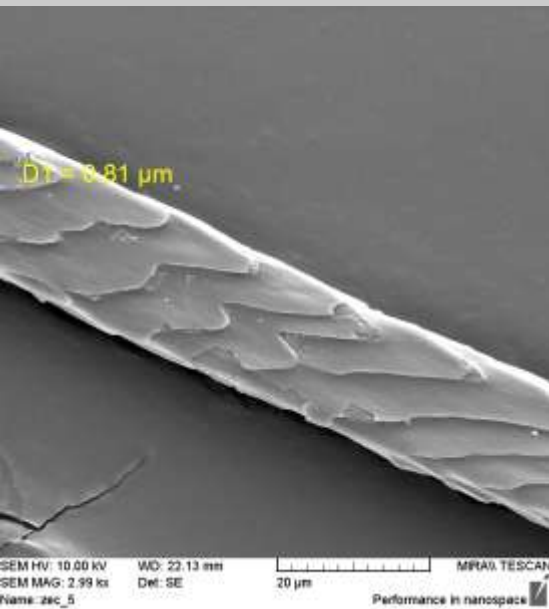
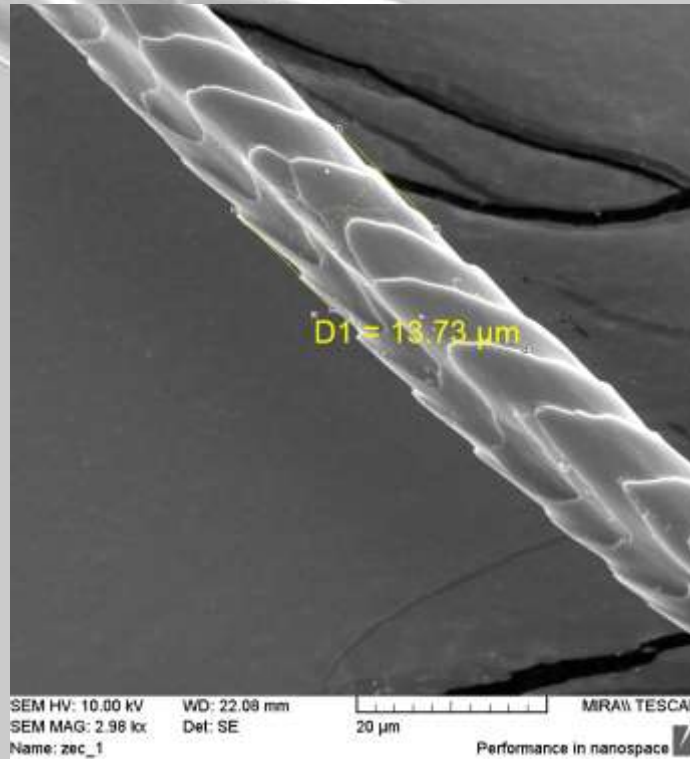
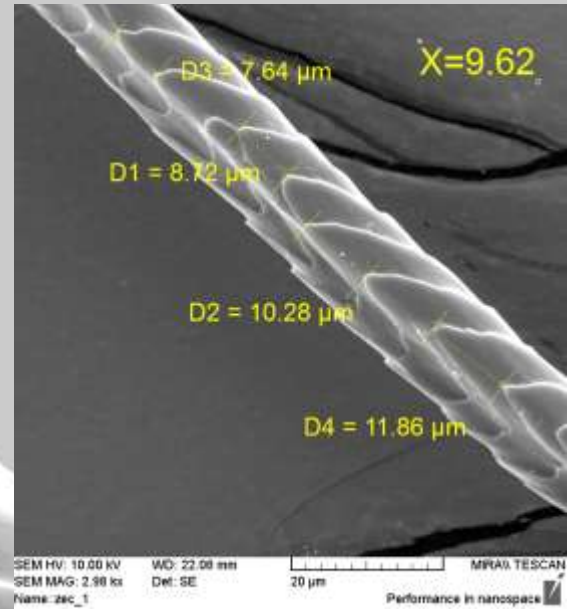


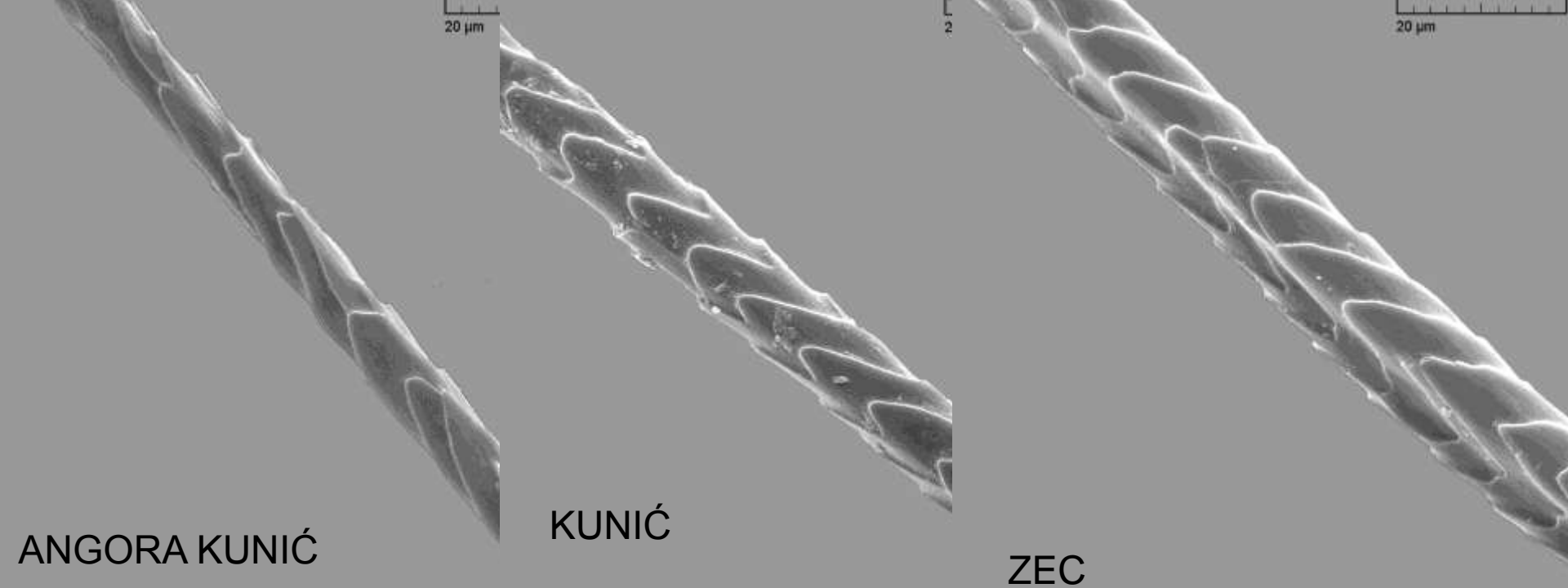
zeec



# ZEC

20  $\mu\text{m}$





- Kutikularne ljuskice su pravilno raspoređene i imaju specifični cik-cak uzorak.
- Jako fina vlakna (7-16  $\mu\text{m}$ ).
- Angora kunić ima duže ljuske od ostalih (10-12  $\mu\text{m}$ ).

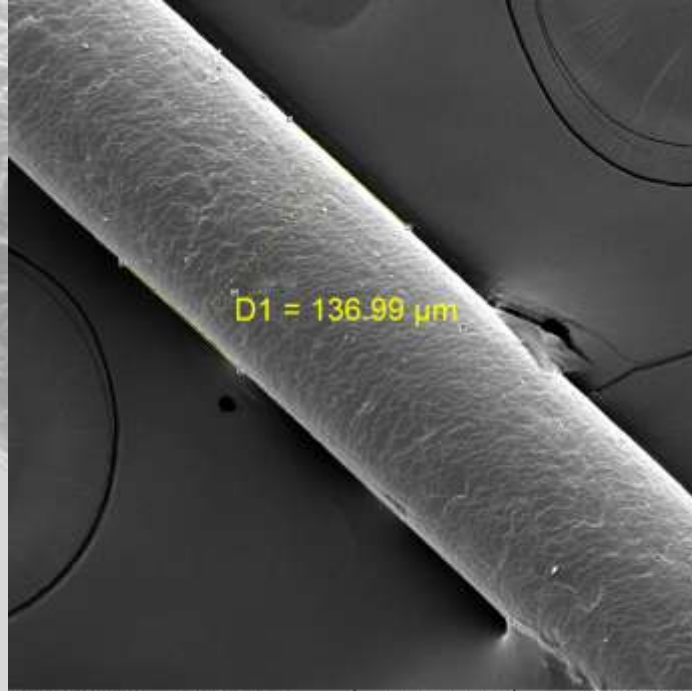
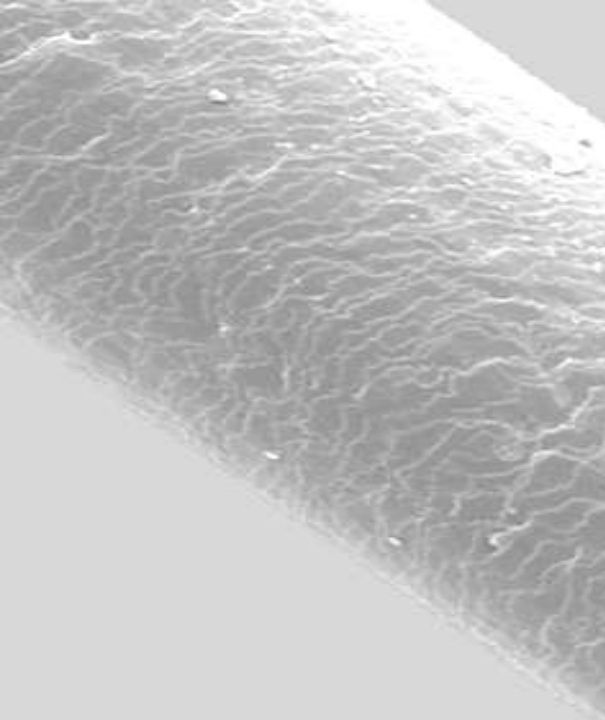
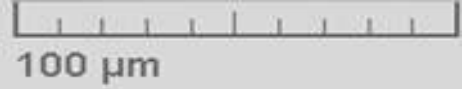
100 µm



**Svinja**

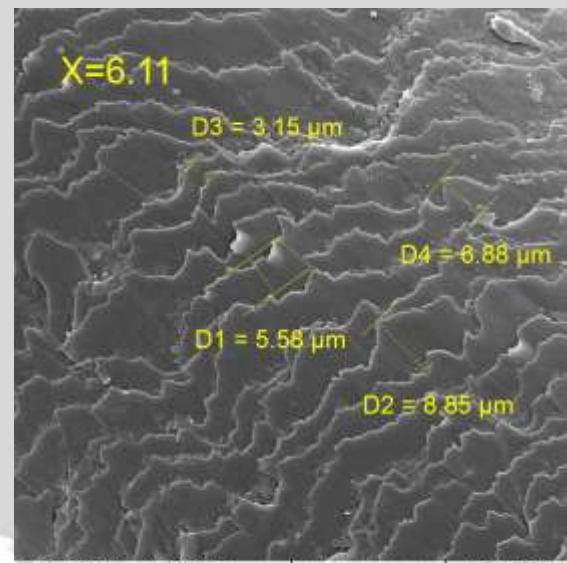
Ren... ture... Copyright... nywell Farm...  
nywellfarm... backgrounds

# SVINJA



D1 = 136.99  $\mu\text{m}$

SEM HV: 10.00 kV WD: 22.18 mm MIRA<sup>3</sup> TESCAN  
SEM MAG: 500 x Det: SE 100  $\mu\text{m}$   
Name: svinja\_1 Performance in nanospace



X=6.11

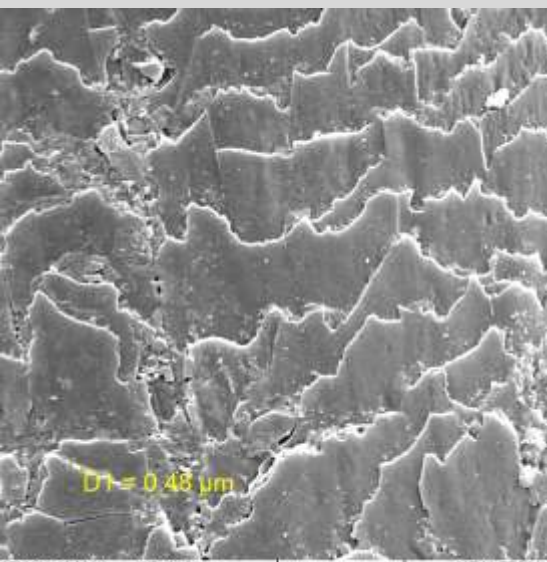
D3 = 3.15  $\mu\text{m}$

D4 = 6.88  $\mu\text{m}$

D1 = 5.58  $\mu\text{m}$

D2 = 8.85  $\mu\text{m}$

SEM HV: 10.00 kV WD: 22.01 mm MIRA<sup>3</sup> TESCAN  
SEM MAG: 3.02 kx Det: SE 20  $\mu\text{m}$   
Name: svinja\_2 Performance in nanospace

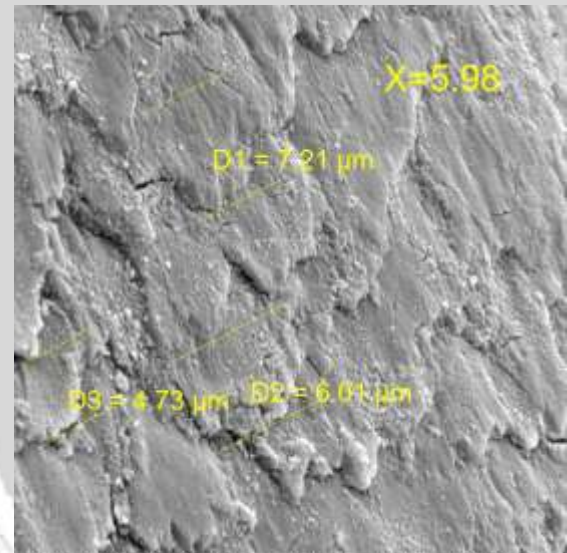


D1 = 0.48  $\mu\text{m}$

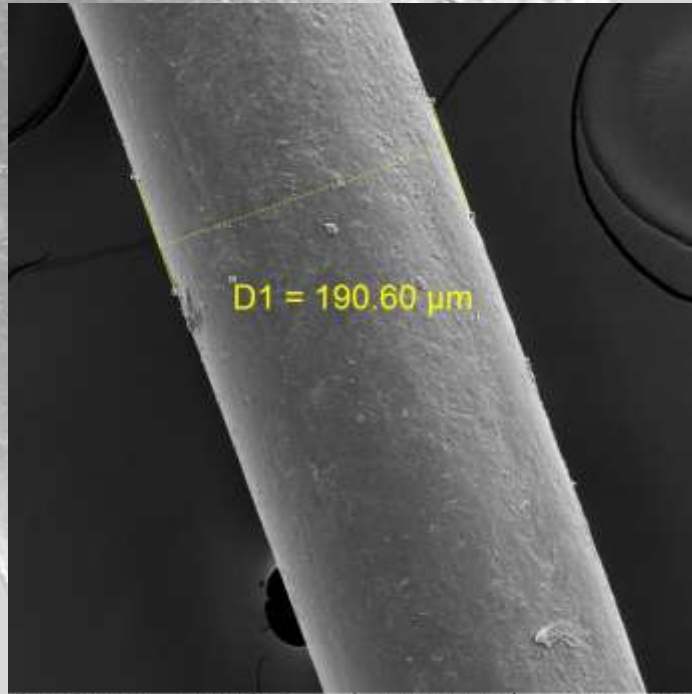
SEM HV: 10.00 kV WD: 21.91 mm MIRA<sup>3</sup> TESCAN  
SEM MAG: 5.00 kx Det: SE 10  $\mu\text{m}$   
Name: svinja\_4 Performance in nanospace



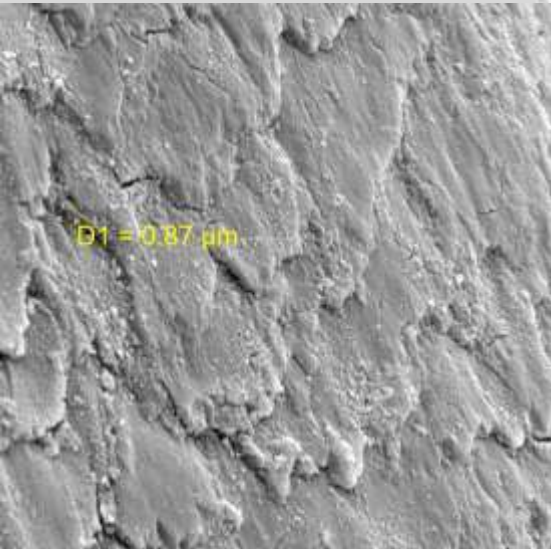
# KONJ



SEM HV: 10.00 kV WD: 22.02 mm MIRA0 TESCAN  
SEM MAG: 6.60 kx Det: SE 10 micrometers  
Name: konj\_3 Performance in nanospace



SEM HV: 10.00 kV WD: 21.91 mm MIRA0 TESCAN  
SEM MAG: 500 x Det: SE 100 micrometers  
Name: konj\_1 Performance in nanospace



SEM HV: 10.00 kV WD: 22.02 mm MIRA0 TESCAN  
SEM MAG: 6.60 kx Det: SE 10 micrometers  
Name: konj\_3 Performance in nanospace



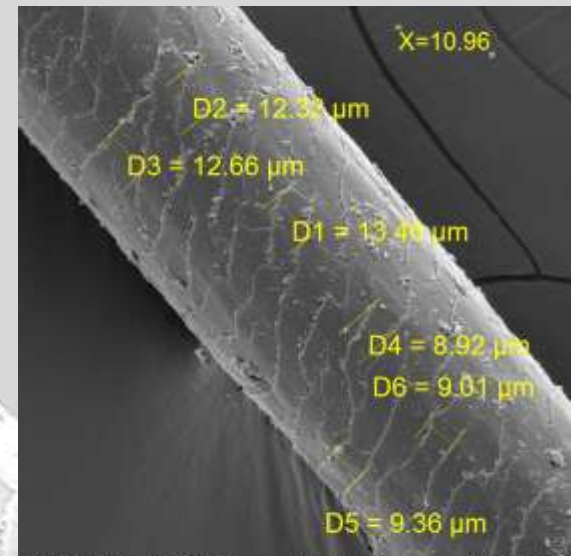


**Govedo**

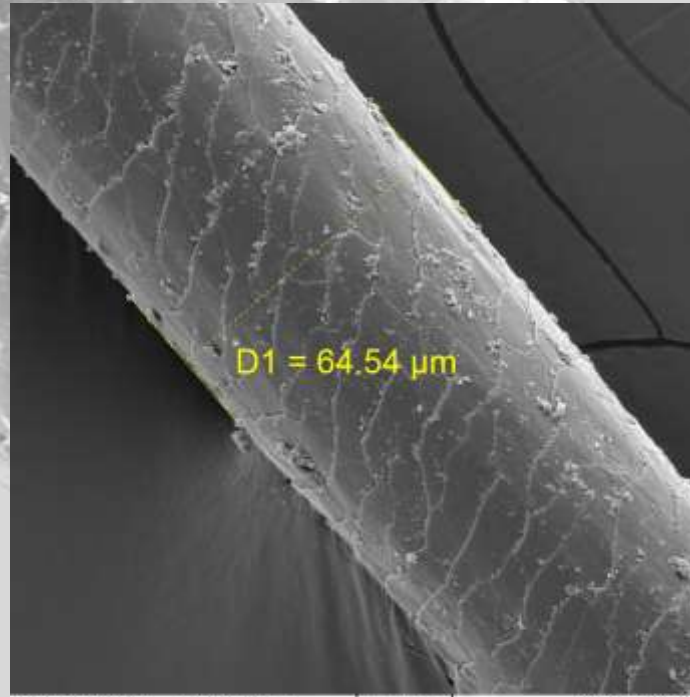
# GOVEDO



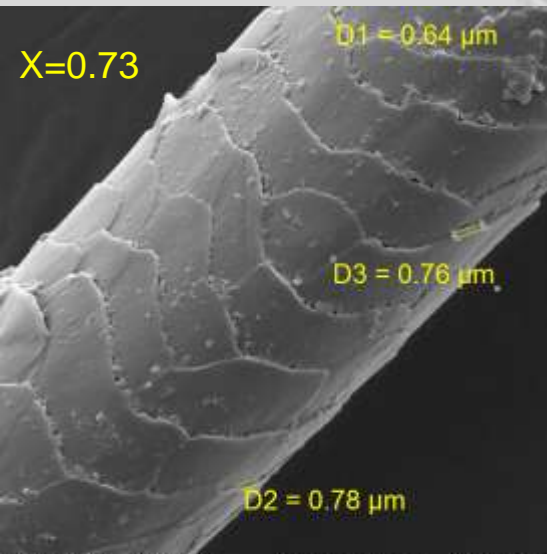
20  $\mu\text{m}$



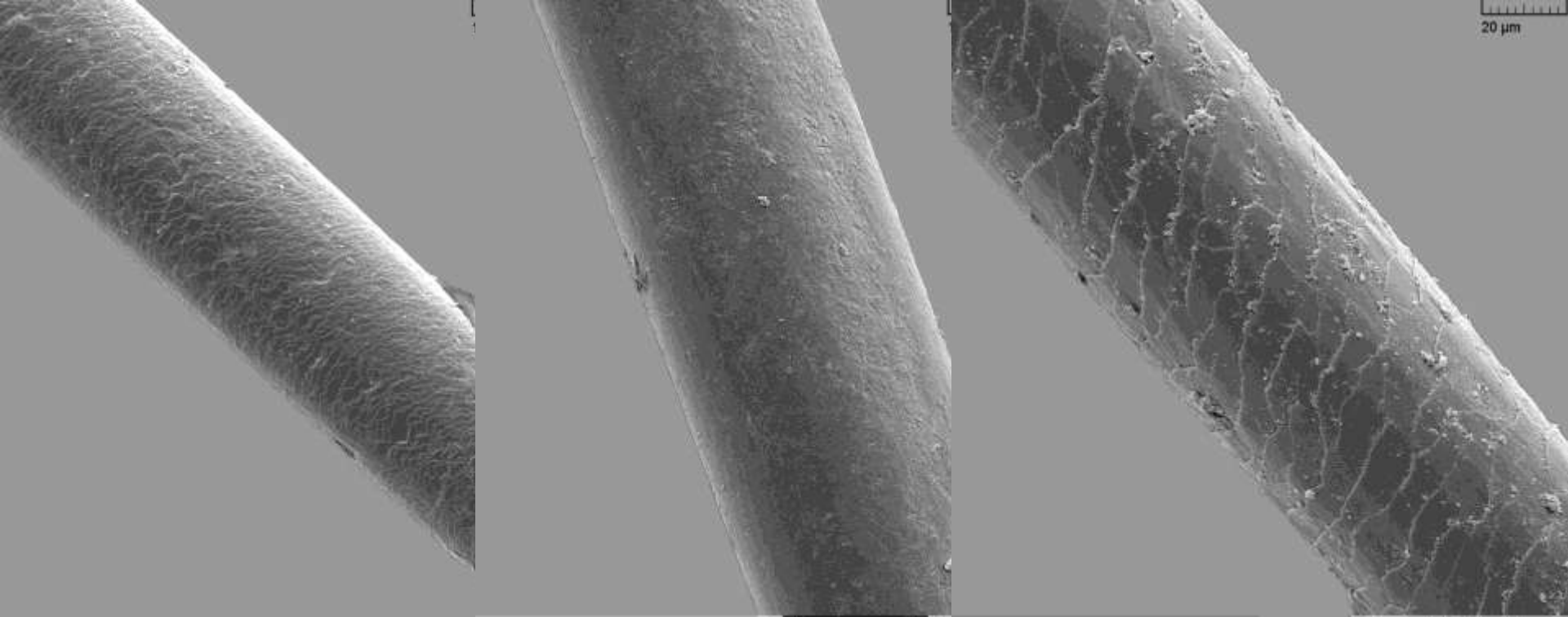
SEM HV: 10.00 kV WD: 22.02 mm MIRA\\ TESCAN  
SEM MAG: 1.50 kx Det: SE 20  $\mu\text{m}$   
Name: goveds\_13 Performance in nanospace



SEM HV: 10.00 kV WD: 22.02 mm MIRA\\ TESCAN  
SEM MAG: 1.50 kx Det: SE 20  $\mu\text{m}$   
Name: govedo\_13 Performance in nanospace



SEM HV: 10.00 kV WD: 22.07 mm MIRA\\ TESCAN  
SEM MAG: 3.00 kx Det: SE 20  $\mu\text{m}$   
Name: goveds\_9 Performance in nanospace

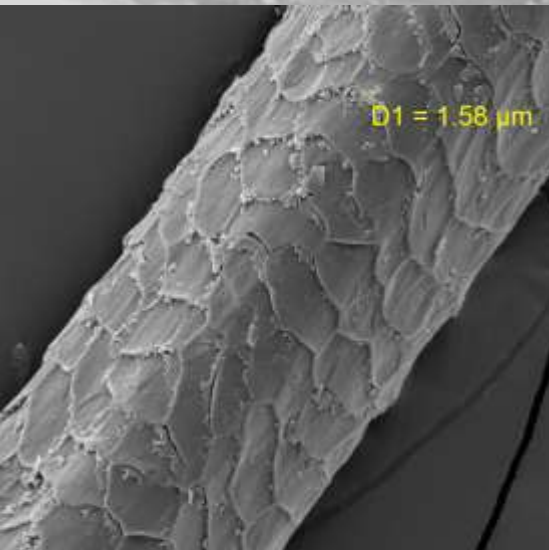
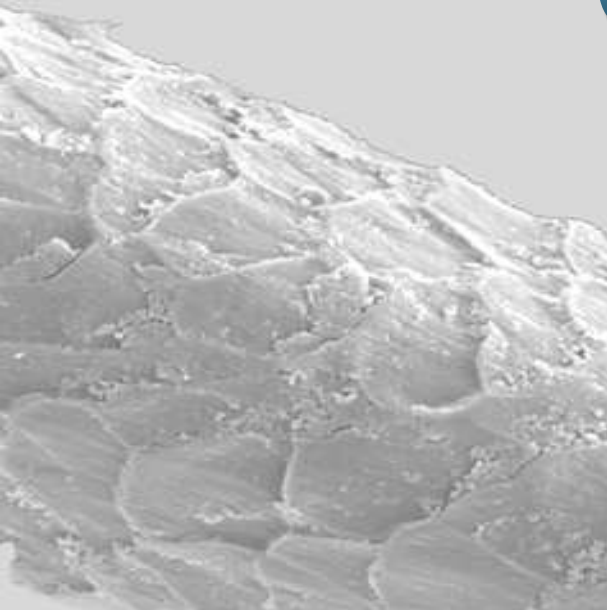


- Čekinje, strune i dlake domaćih životinja.
- Kod svinje i konja na 100  $\mu\text{m}$  brojimo oko 15-20 ljusaka, dok govedo ima oko 10 ljusaka na 100  $\mu\text{m}$ .
- Gušća raspoređenost ljusaka utječe na hrapavost vlakna, na trenje i samim time na opip tog istog vlakna.
- Primjena najviše za izradu raznih četki, kistova, itd.

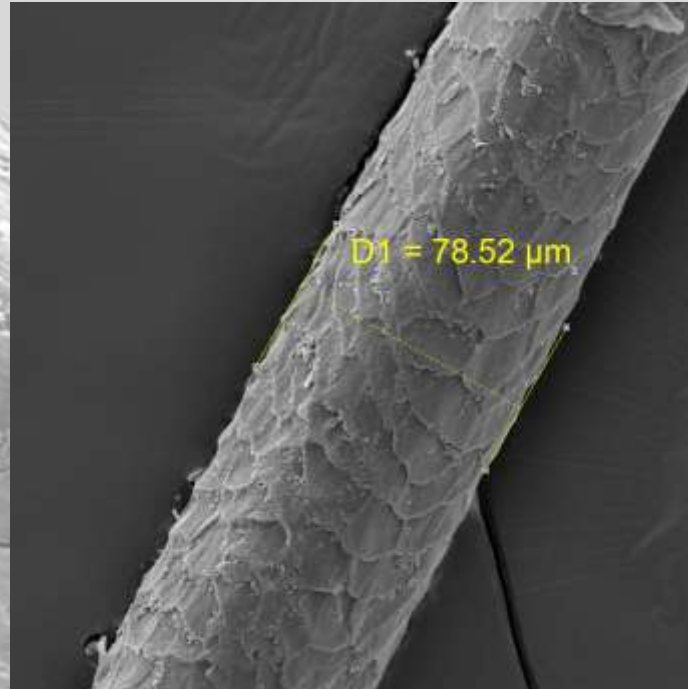


Jelen

# JELEN



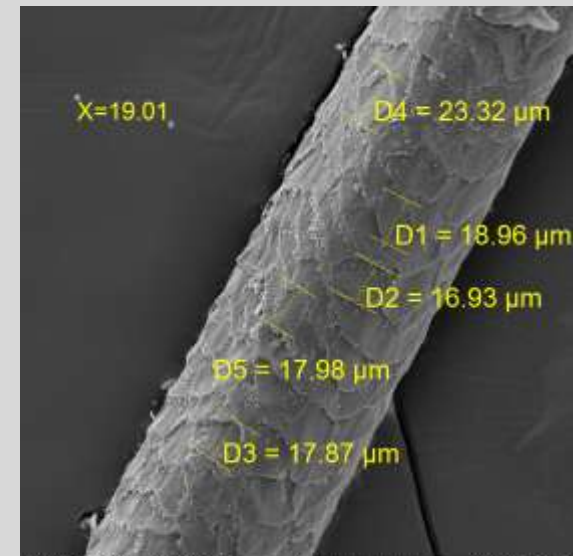
SEM HV: 10.00 kV WD: 22.14 mm MIRA0 TESCAN  
SEM MAG: 1.50 kx Det: SE 20 μm  
Name: jelen\_2 Performance in nanospace



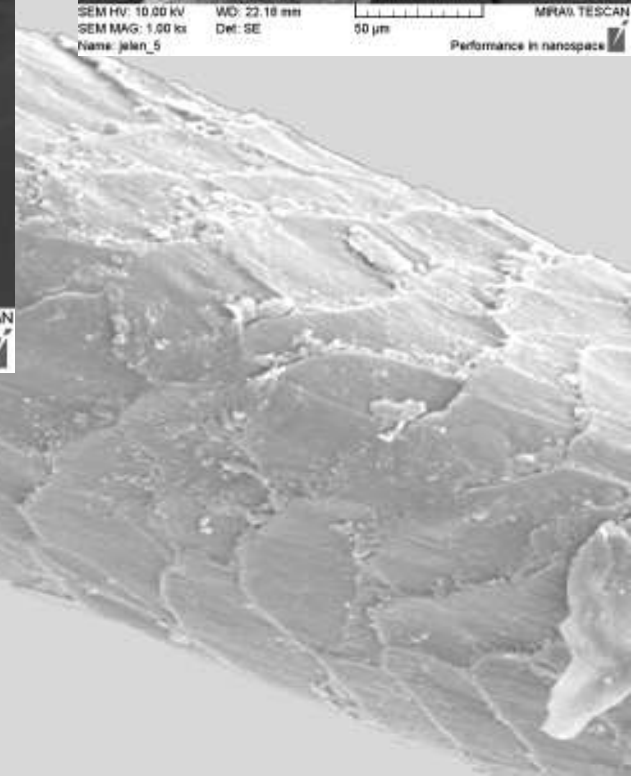
SEM HV: 10.00 kV WD: 22.18 mm MIRA0 TESCAN  
SEM MAG: 1.00 kx Det: SE 50 μm  
Name: jelen\_5 Performance in nanospace



50 μm



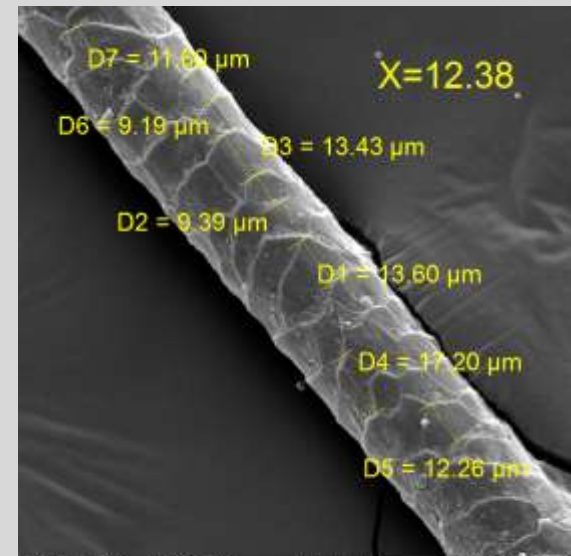
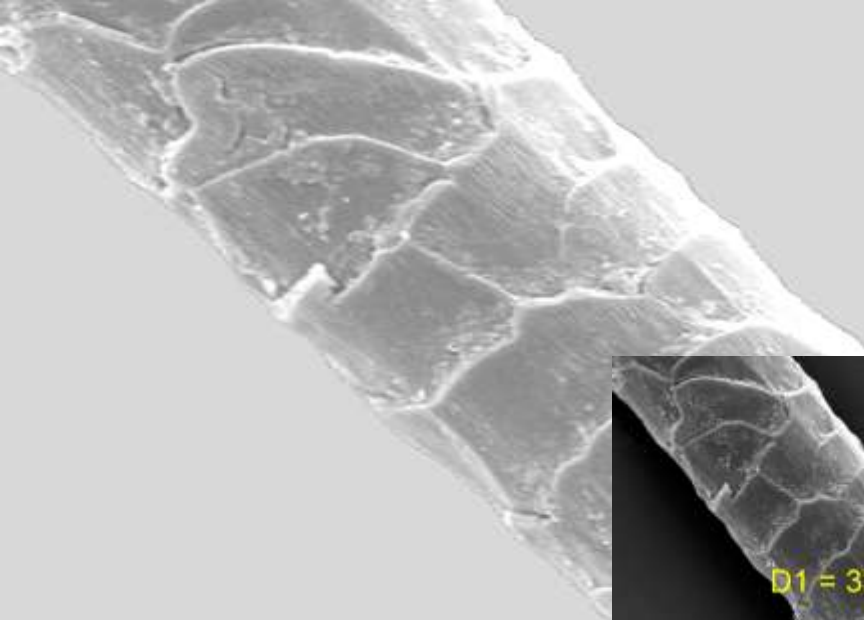
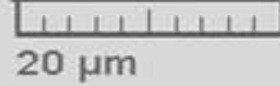
SEM HV: 10.00 kV WD: 22.18 mm MIRA0 TESCAN  
SEM MAG: 1.00 kx Det: SE 50 μm  
Name: jelen\_5 Performance in nanospace



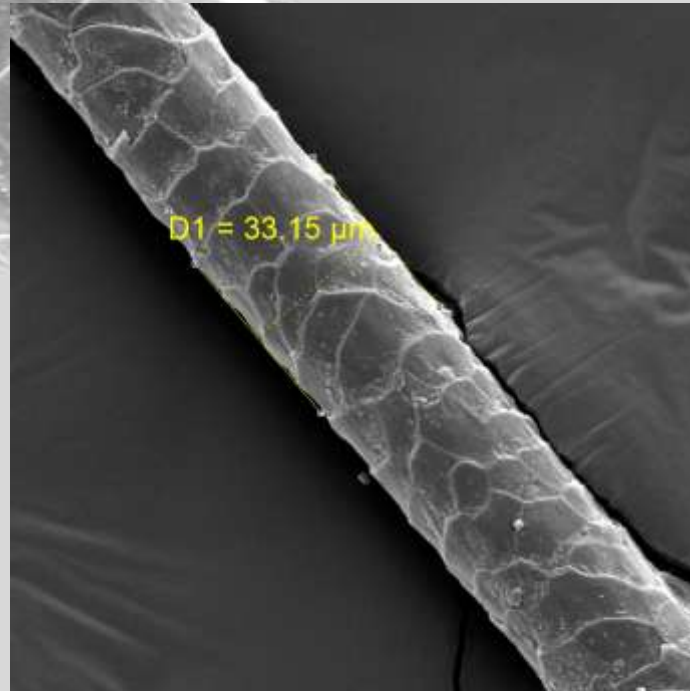


**SoB**

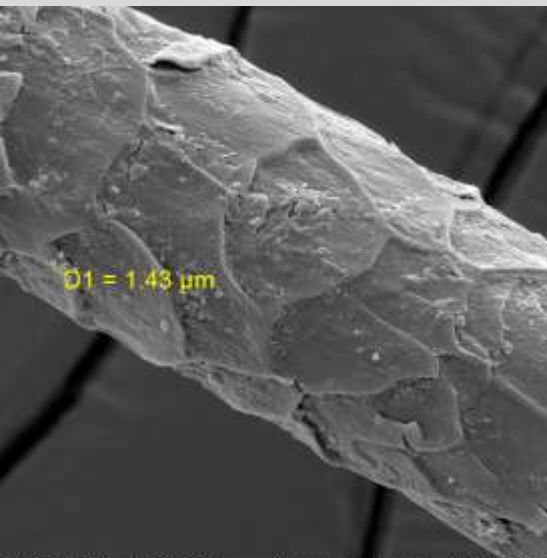
# SOB



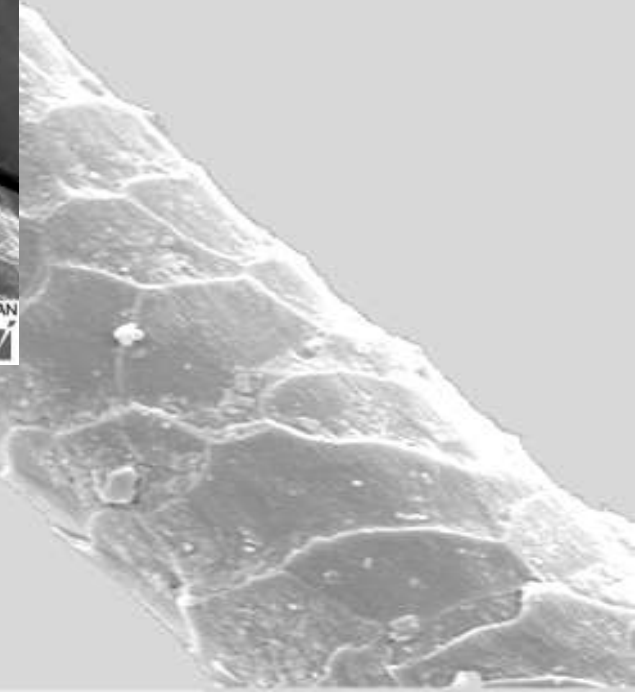
SEM HV: 10.00 kV WD: 22.09 mm MIRA\ TESCAN  
SEM MAG: 1.50 kx Det: SE 20  $\mu\text{m}$   
Name: sob\_10 Performance in nanospace

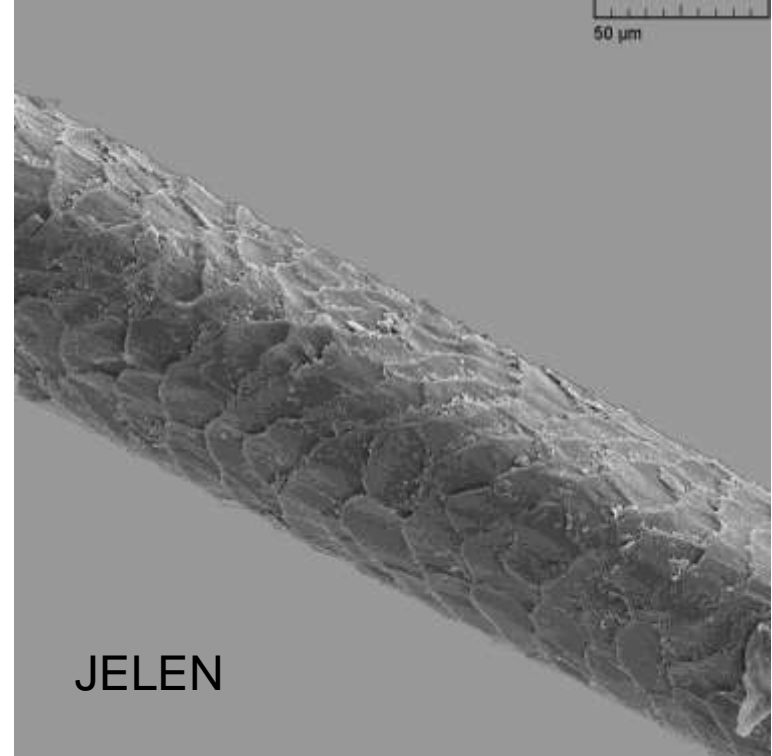
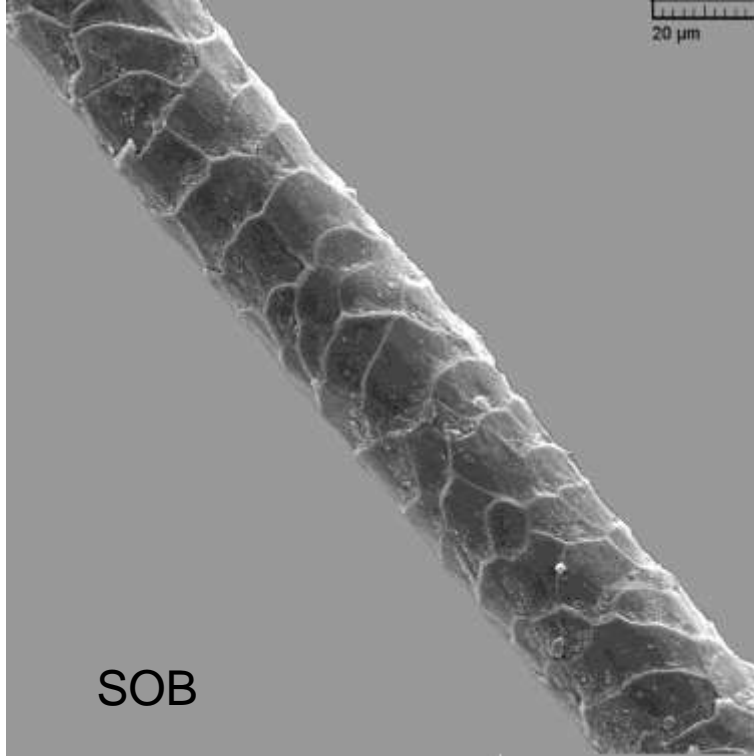


SEM HV: 10.00 kV WD: 22.09 mm MIRA\ TESCAN  
SEM MAG: 1.50 kx Det: SE 20  $\mu\text{m}$   
Name: sob\_10 Performance in nanospace



SEM HV: 10.00 kV WD: 21.98 mm MIRA\ TESCAN  
SEM MAG: 3.00 kx Det: SE 20  $\mu\text{m}$   
Name: sob\_13 Performance in nanospace





- Mrežaste ljuske nepravilnog, mnogokutnog oblika.
- I ove ljuske leže tako da su jednim dijelom utaknute jedna u drugu i time uzrokuju hrapavost površine vlakna.



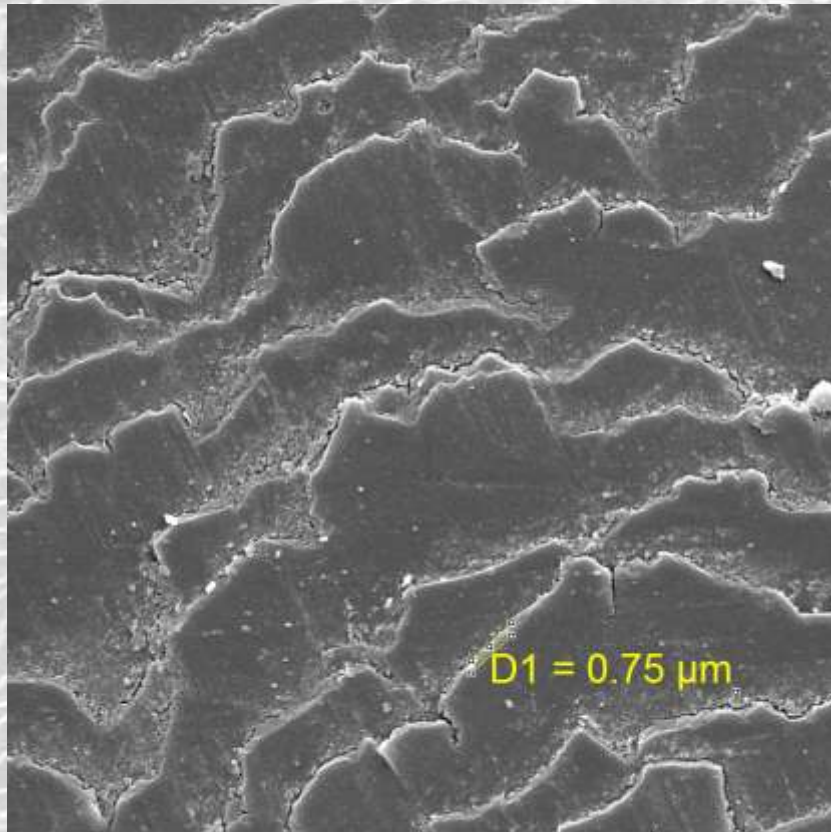
# Dikobraz



# DIKOBRAZ



100  $\mu\text{m}$



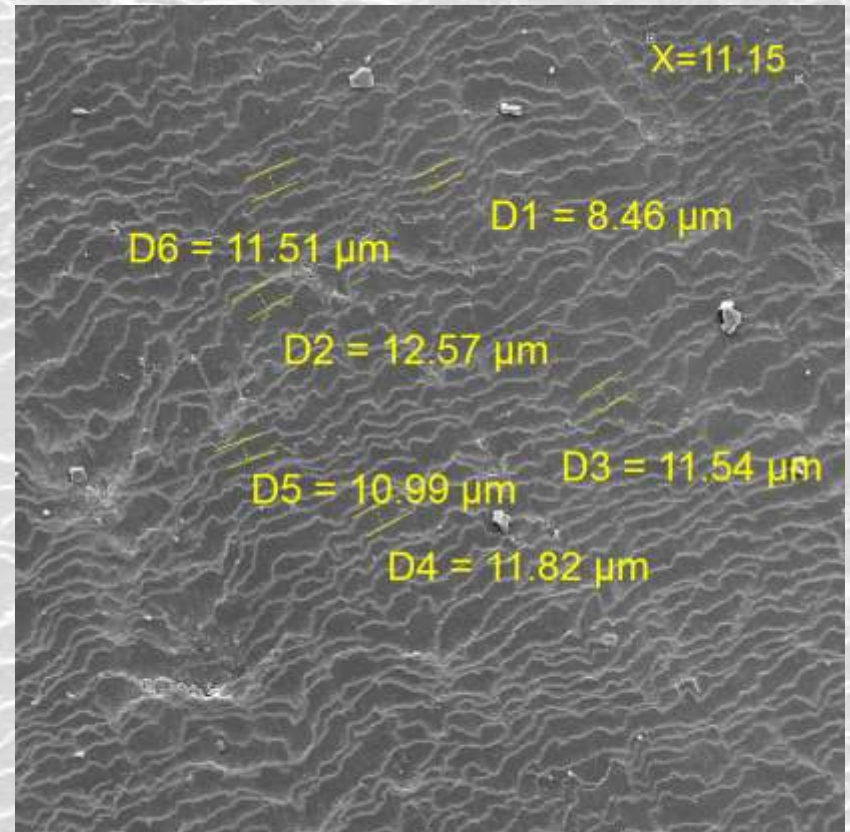
D1 = 0.75  $\mu\text{m}$

SEM HV: 10.00 kV WD: 21.71 mm  
SEM MAG: 3.00 kx Det: SE  
Name: dikobraz\_3

20  $\mu\text{m}$

MIRA\ TESCAN

Performance in nanospace



X=11.15

D6 = 11.51  $\mu\text{m}$

D1 = 8.46  $\mu\text{m}$

D2 = 12.57  $\mu\text{m}$

D5 = 10.99  $\mu\text{m}$

D3 = 11.54  $\mu\text{m}$

D4 = 11.82  $\mu\text{m}$

SEM HV: 10.00 kV WD: 21.68 mm  
SEM MAG: 500 x Det: SE  
Name: dikobraz\_1

100  $\mu\text{m}$

MIRA\ TESCAN

Performance in nanospace

# ZAKLJUČAK

- Na izgled ljusaka utječe mnoštvo faktora:
- Vrsta životinje.
- Vrsta dlake (osjasta, pahuljasta).
- S kojeg dijela tijela životinje je dlaka uzeta.
- Prirodno stanište životinje, uvjeti okoline.
- Sve ove faktore treba uzeti u obzir prije SEM identifikacije i naravno naoružati se strpljenjem i vremenom jer je za identifikaciju potrebno ispitivanje na većem broju dlaka i puno više pojedinačnih mjerenja.





Merry  
Christmas

Hvala na pažnji!!!