BRUKER NANO ANALYTICS

Analytical Cryo-SEM EDS Mapping for Biological and Life Science Applications

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Am Studio 2D
12489 Berlin, Germany

Today‘s Speakers

Dr. Purvesh Soni

Sr. Application Scientist EDS

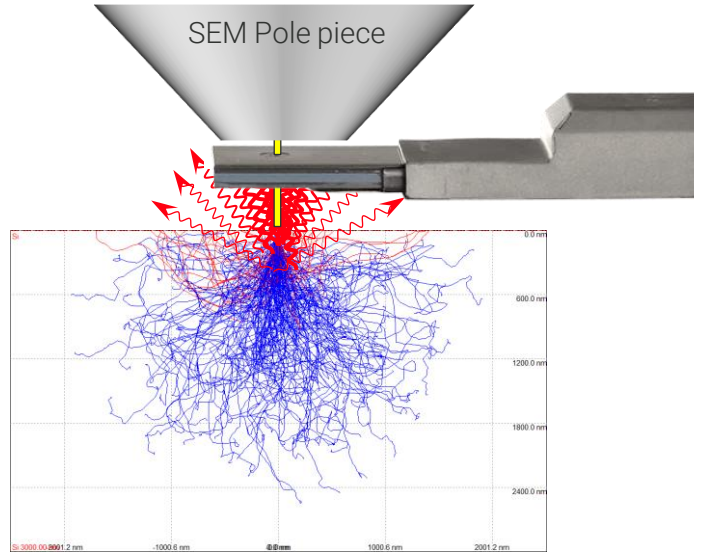
Bruker Nano Analytics, Berlin

Dr. Ifat Kaplan-Ashiri

Associate Staff Scientist
Electron Microscopy Unit,
Department of Chemical Research Support,
Weizmann Institute of Science

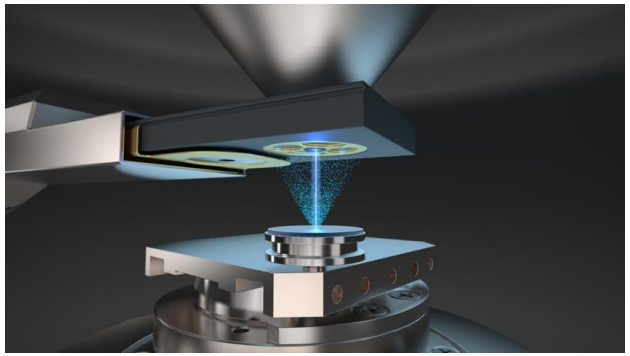
XFlash® FlatQUAD
Highest solid angle for SEM EDS

- Side entry EDS – Similar to retractable BSE
- Annular 4-segment design
- Optimum geometry for signal collection



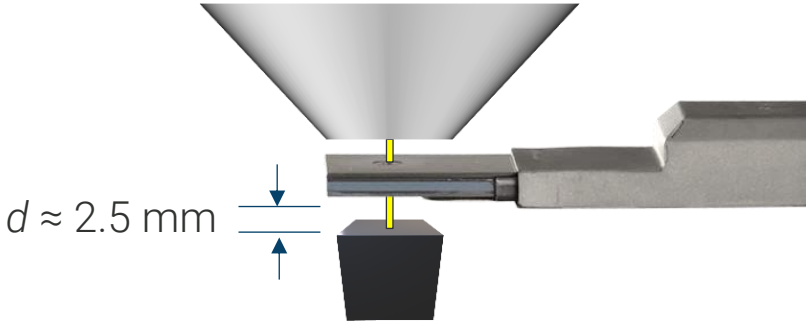
XFlash® FlatQUAD

XFlash® FlatQUAD
Highest sensitivity SEM EDS detector



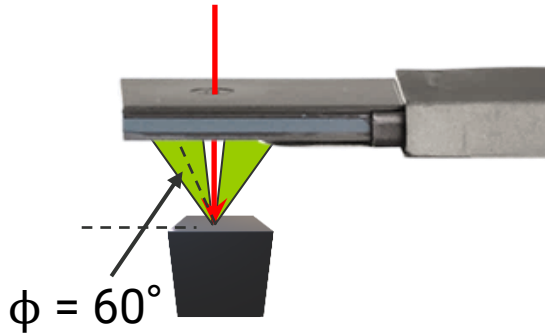
4 segment annular SDD design

-> Minimal shadowing for topographic samples



Highest solid angle (up to 1.1 sr)

-> Highest sensitivity



Highest take off angle

-> Highest signal intensity

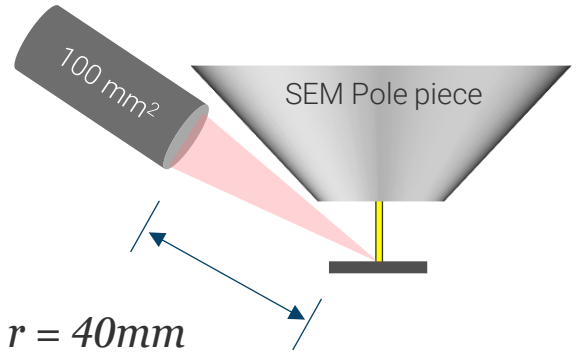
Ultra low probe currents (low/high kV)

Highest sensitivity

3,200,000 cps Output count rate

Solid angle and detector geometry

Collection efficiency FlatQUAD vs Conventional inclined EDS



For spheres, solid angle is:

$$\Omega \sim \frac{A}{r^2}$$

100 mm² SDD chip at 40 mm

Solid angle = 0.0625 sr

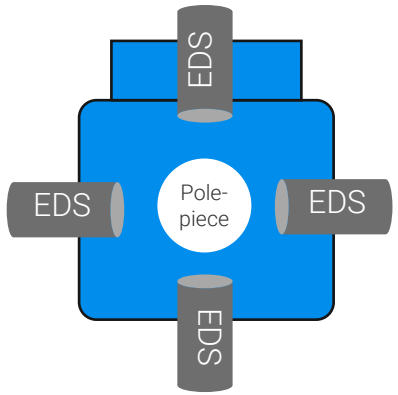
Multiple EDS detectors vs FlatQUAD

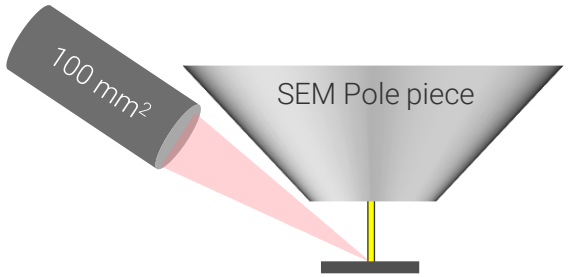
Solid angle, detector geometry and X-Ray photon collection

100 mm² SDD chip at 40 mm
Solid angle = 0.0625 sr

4 x 100 mm²

= 0.25 sr





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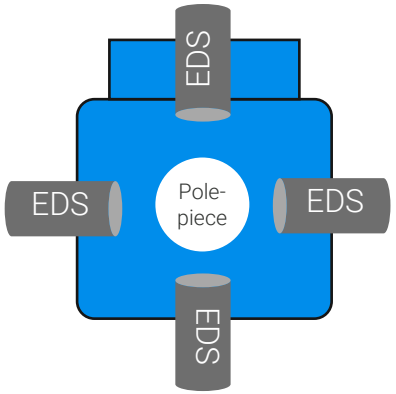
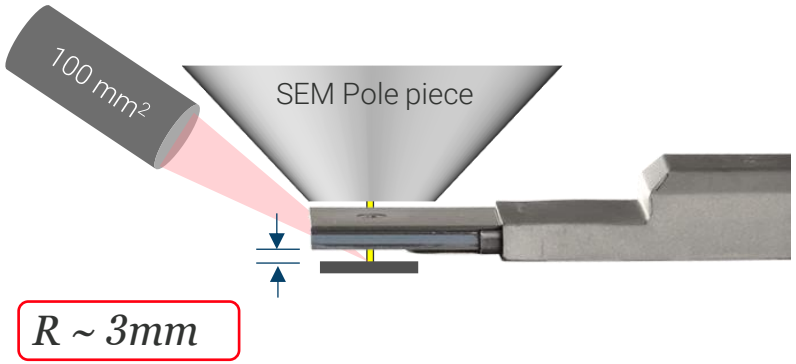




FlatQUAD

Solid angle
~ 1.0 sr

10x – 20x higher solid angle

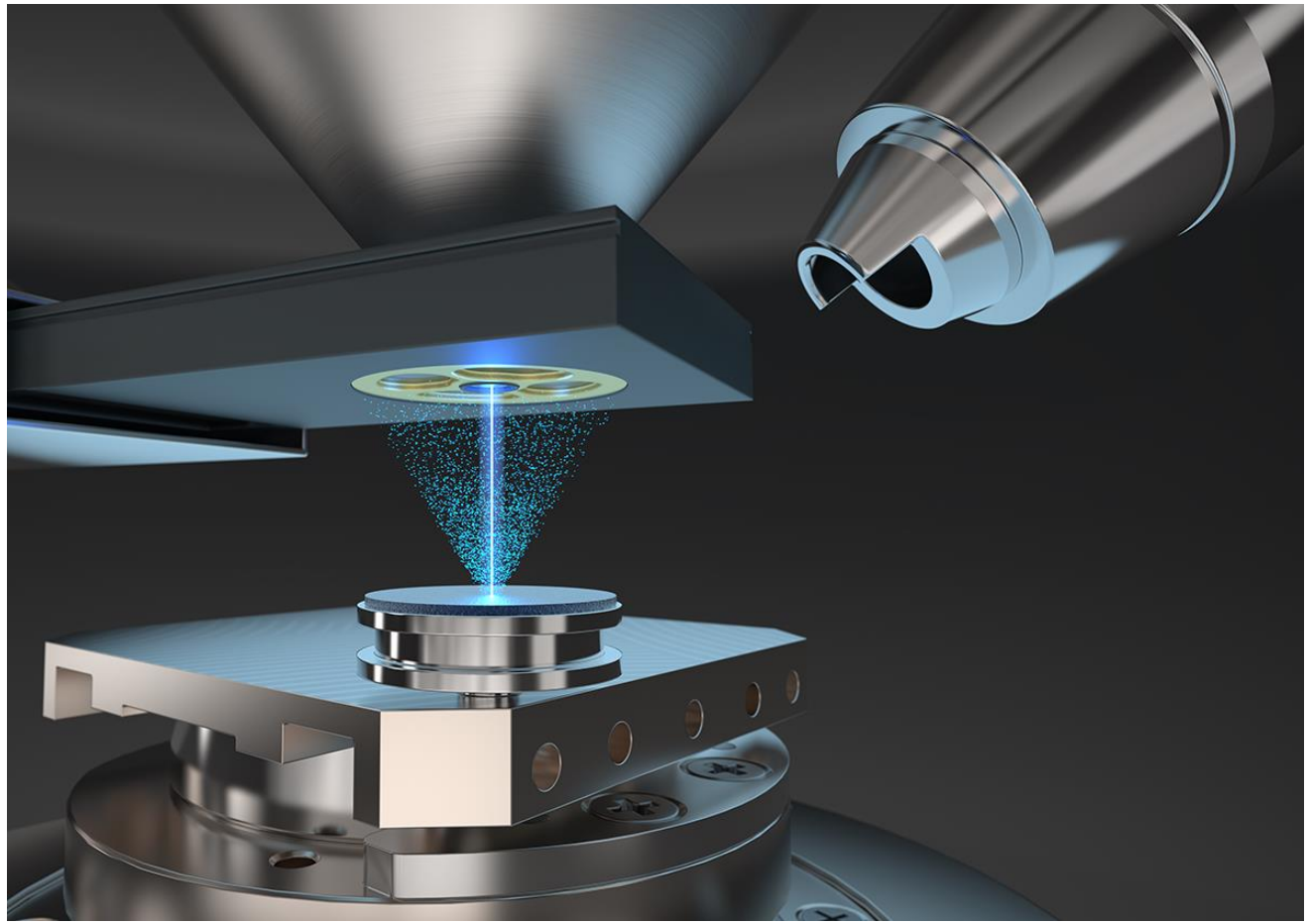
Benchmark tests

Cu sample at 5 kV measured at different probe currents

Probe current	Input count rate (ICR)	Output count rate (OCR)
18 pA	8,288 cps	8,199 cps
237 pA	106,300 cps	89,700 cps
1.32 nA	597,200 cps	481,600 cps
5.27 nA	2,154,000 cps	1,023,300 cps

~ 4600 cps at 10 pA (Cu at 5 kV)

QUANTAX FlatQUAD vs conventional inclined EDS detector



- > 25 x higher collection solid angle
- 2 x higher take-off angle
- Up to 3,200,000 output count rates
- Light element detection from B (Z=5) and quantification
- Highest sensitivity at low kV and ultra low probe currents

For more information, please visit

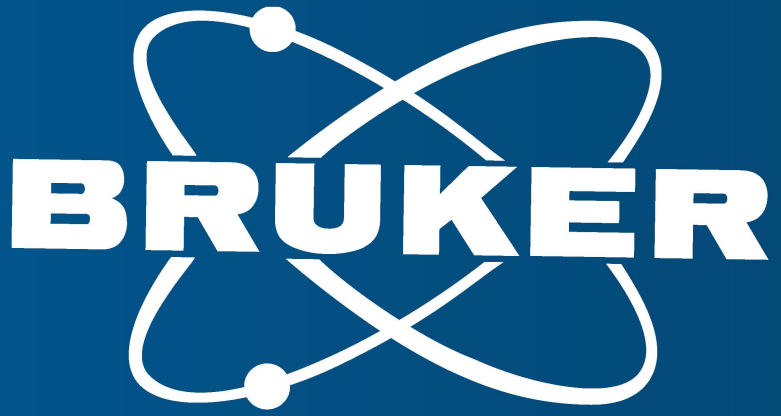
www.bruker.com/XFlash7

or contact your local sales representative or

info.bna@bruker.com

Thank you!

info.bna@bruker.com



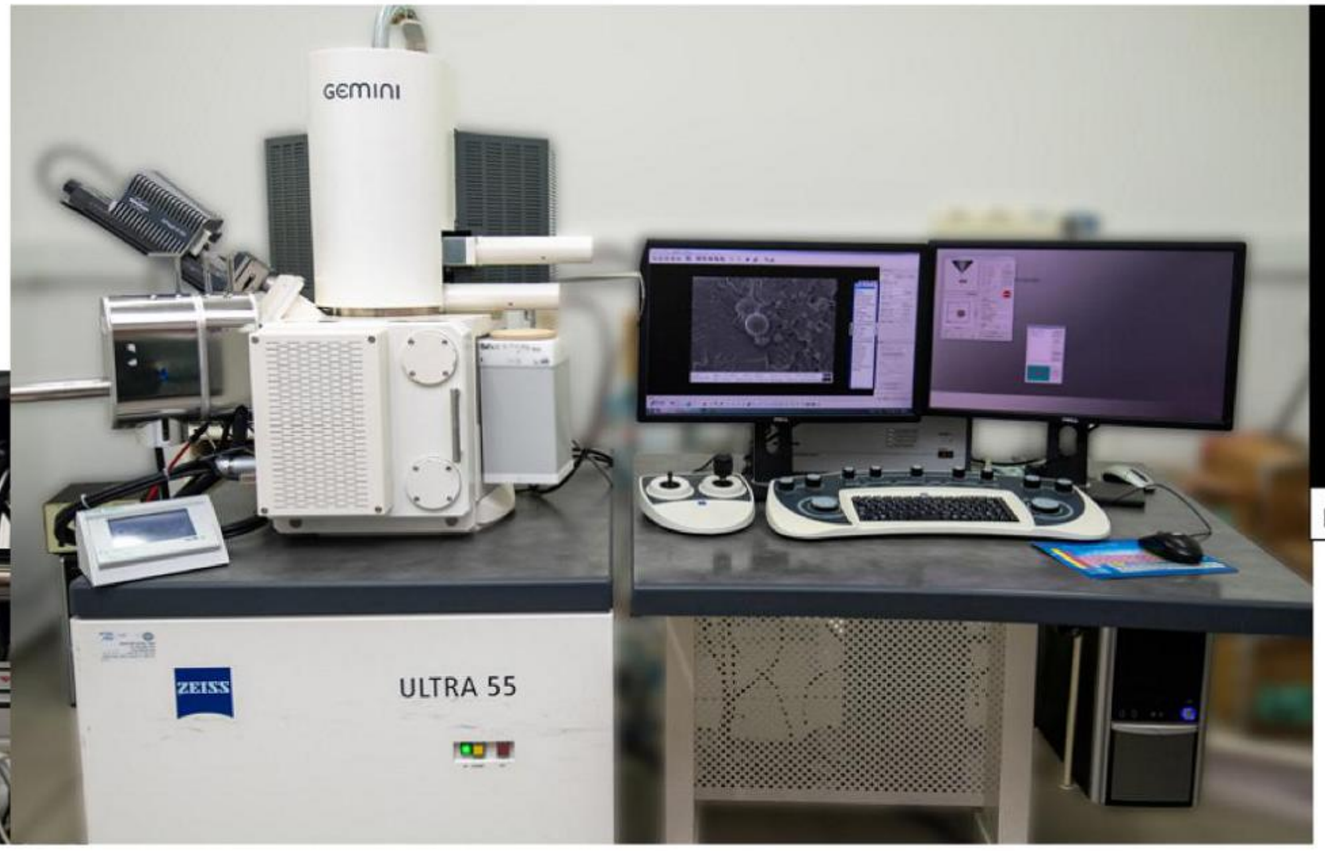
Innovation with Integrity

Cryo-SEM EDS in Life Science

Ifat Kaplan-Ashiri, Electron Microscopy Unit, Weizmann Institute of Science

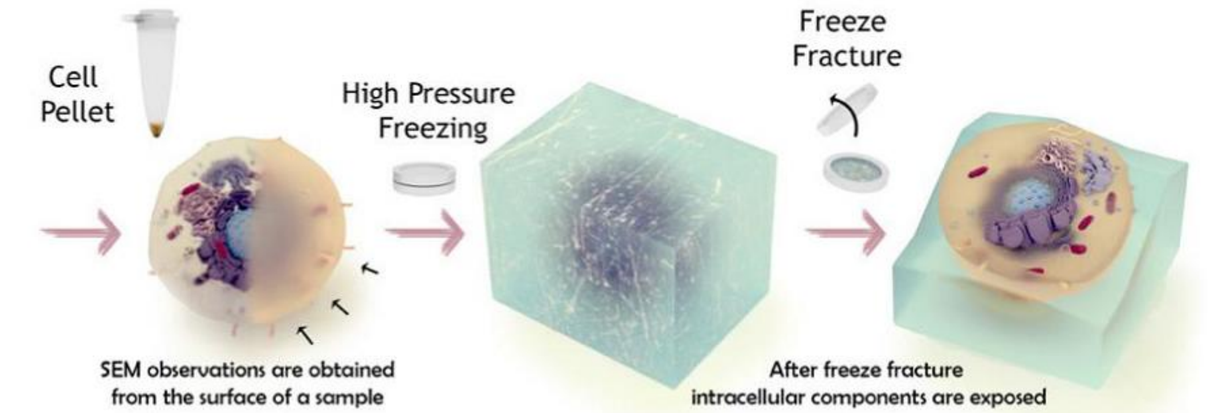
Au

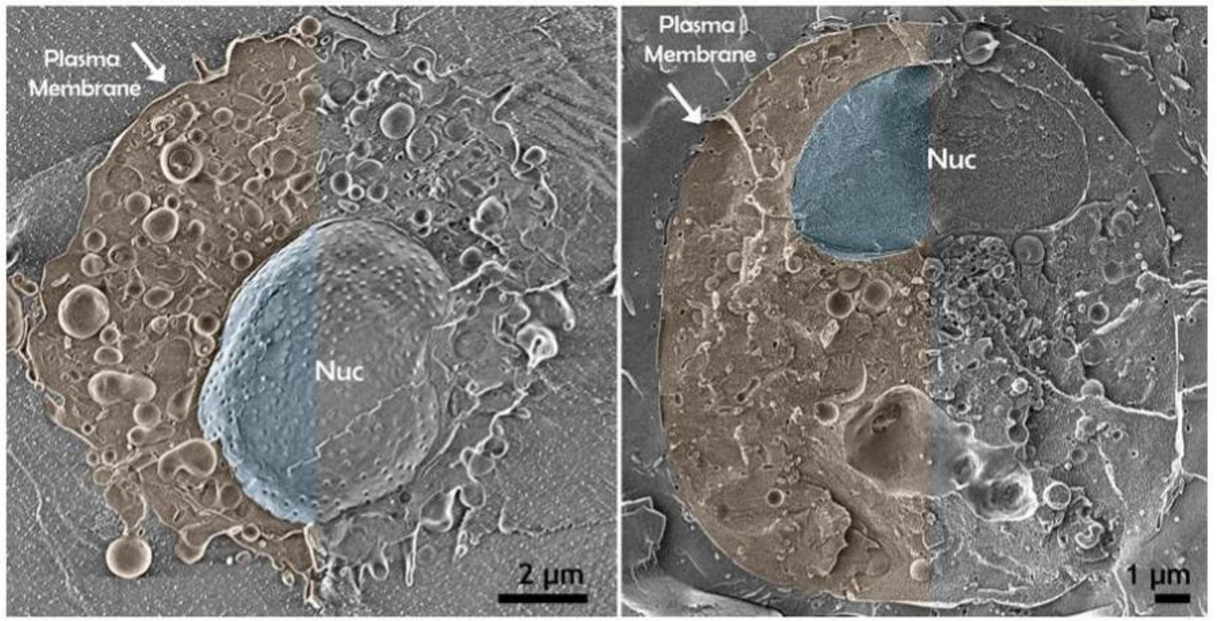
Instrumentation



Zeiss Ultra55 equipped with Leica cryo stage and 2 EDS systems – XFlash60 and FlatQUAD

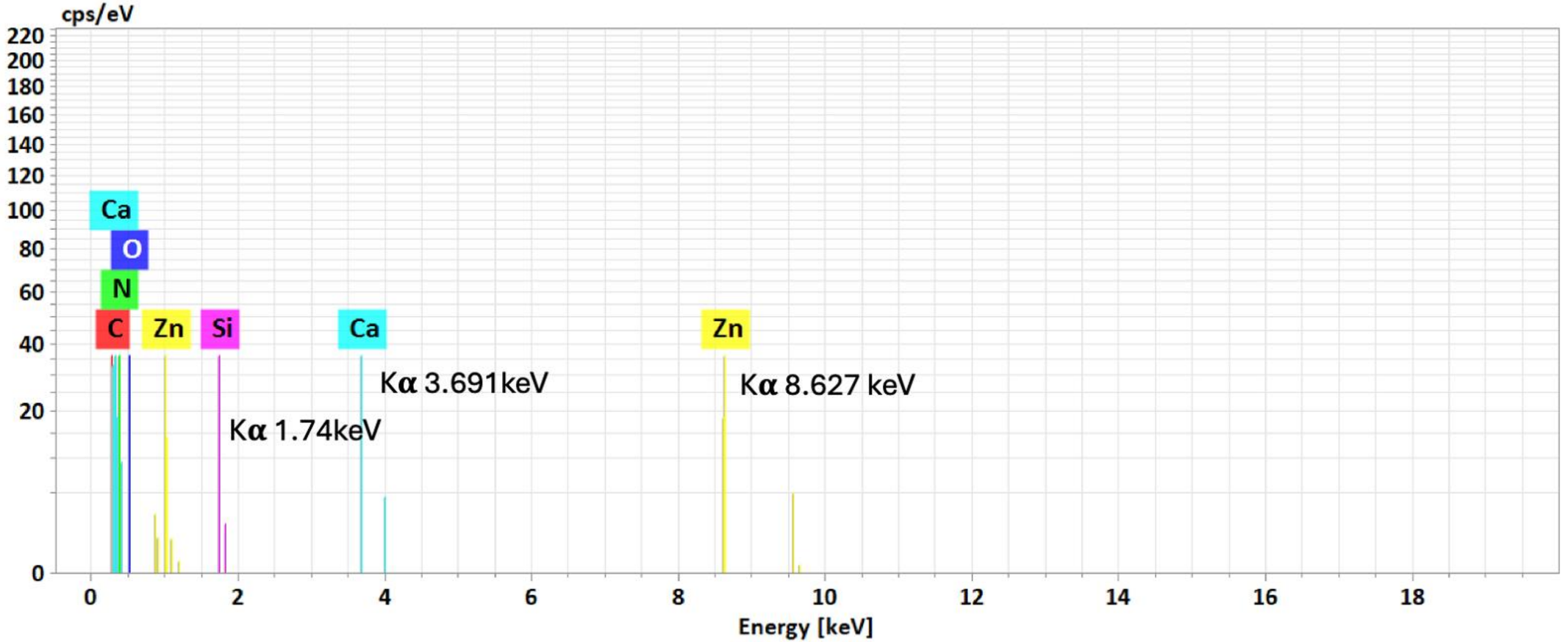
Cryo-SEM sample preparation





Dr. Neta Varsano, Electron Microscopy Unit, Weizmann Institute of Science

Cryo-SEM EDS


cps/eV
220
200
180
160
140
120
100
80
60
40
20
0
Ca
O
N
C
Zn
Si
Ca
Zn
Kα 3.691keV
Kα 1.74keV
Kα 8.627 keV
0
2
4
6
8
10
12
14
16
18
Energy [keV]

Cryo-SEM EDS

The challenges:

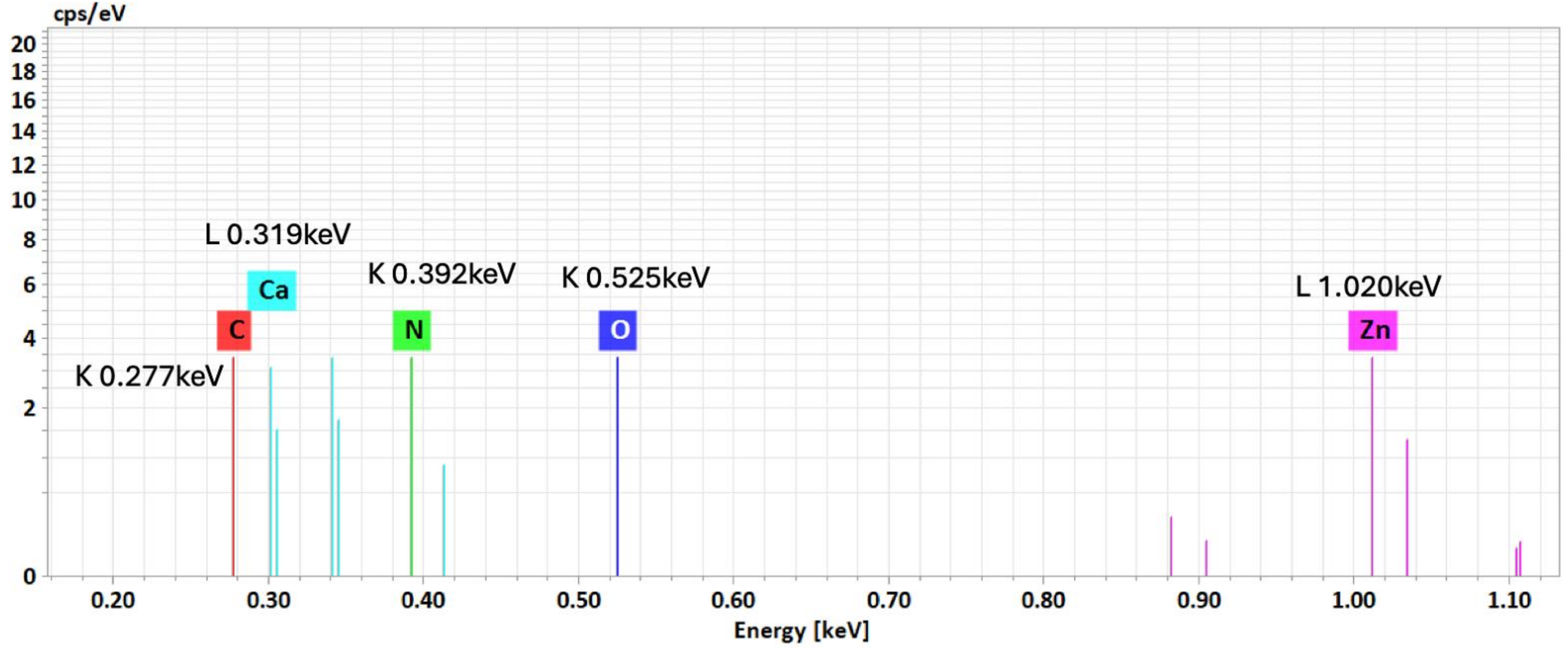
The samples are Beam sensitive and Non-conductive

The amount of mineral compared to carbon and oxygen is small

EDS requires different acceleration voltage, current and working distances than SEM imaging

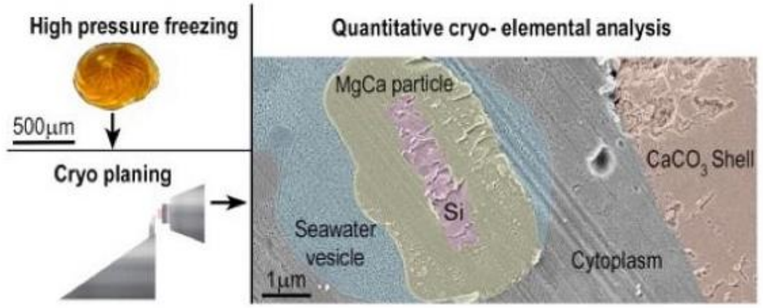
Topography

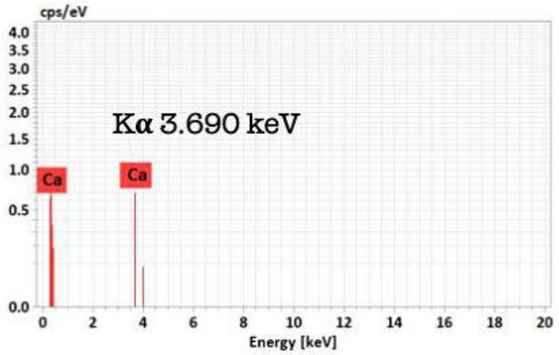
Cryo-SEM EDS


cps/eV
20
18
16
14
12
10
8
6
4
2
0
L 0.319keV
Ca
C
K 0.277keV
K 0.392keV
N
K 0.525keV
O
L 1.020keV
Zn
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
Energy [keV]

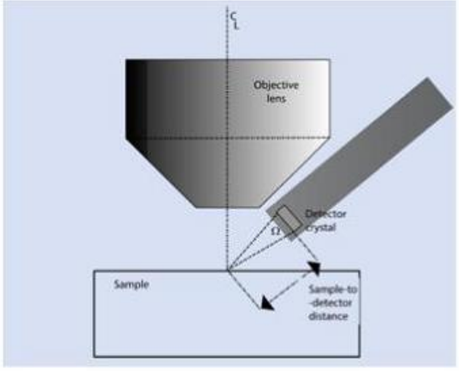
Characterization of unusual MgCa particles involved in the formation of foraminifera shells using a novel quantitative cryo SEM/EDS protocol

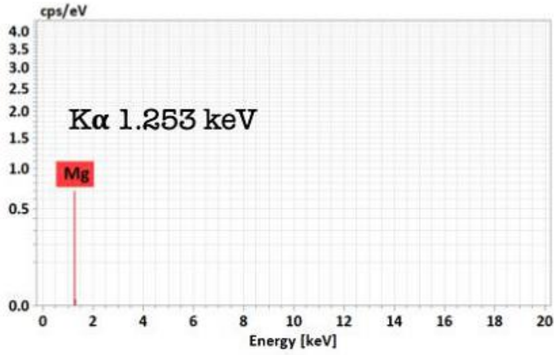
Gal Mor Khalifa et al. Acta Biomaterialia 77 (2018) 342–351





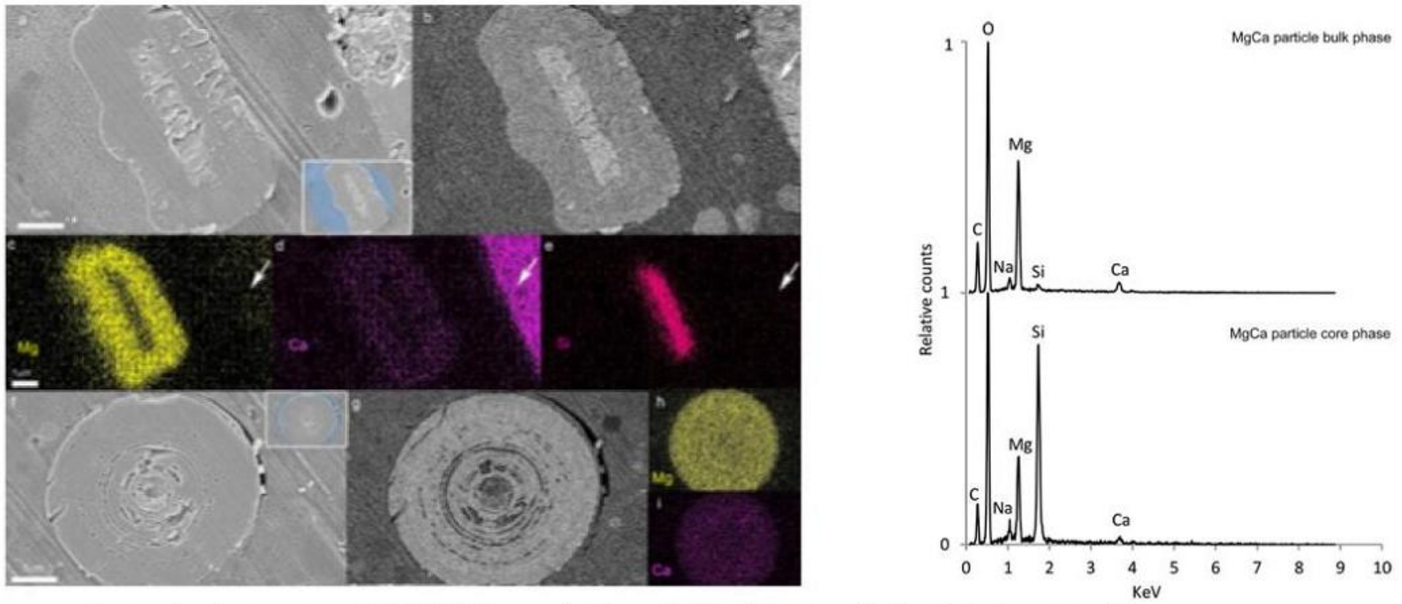
Cryo EDS workflow:
HPF
Cryo planning (to get flat surface)
SE and BS imaging at low kV
C coating (10nm)
EDS mapping





Dr. Gal Mor Khalifa, Prof. Lia Addadi and Prof. Steve Weiner group, Chemical and Structural Biology Dept., WIS

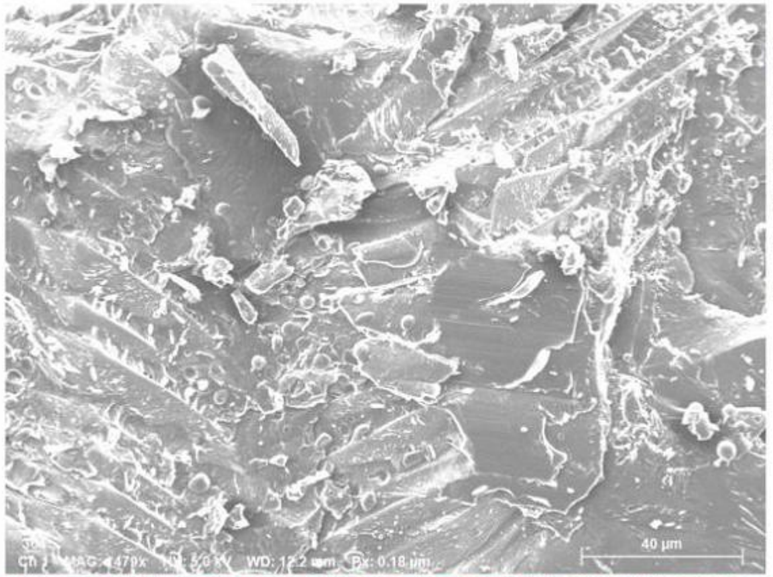
Characterization of unusual MgCa particles involved in the formation of foraminifera shells using a novel quantitative cryo SEM/EDS protocol

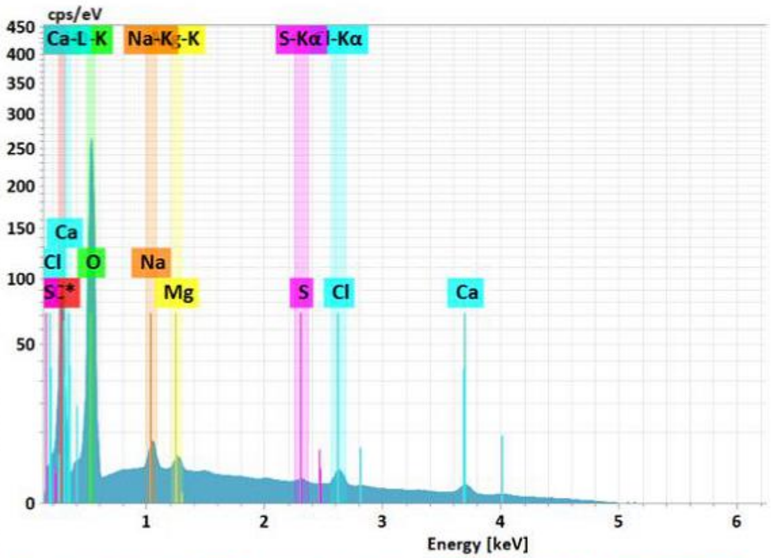


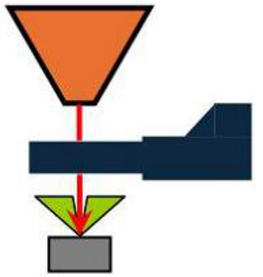
Correlative cryo- SEM/EDS analysis of two intracellular MgCa particles

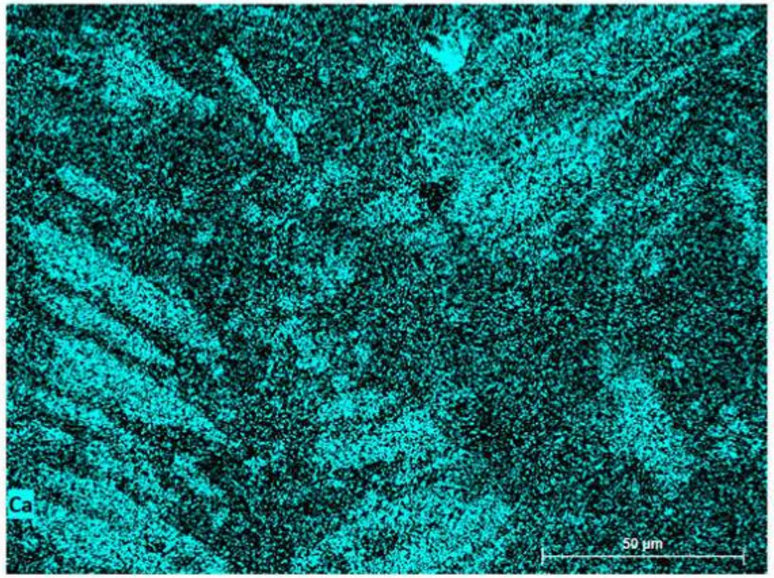
Gal Mor Khalifa et al. Acta Biomaterialia 77 (2018) 342–351

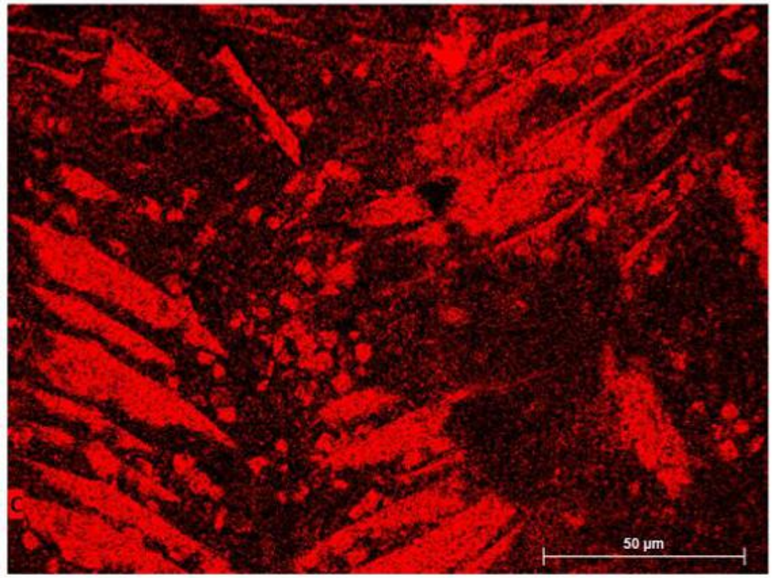
Cryo EDS of sea urchin tooth





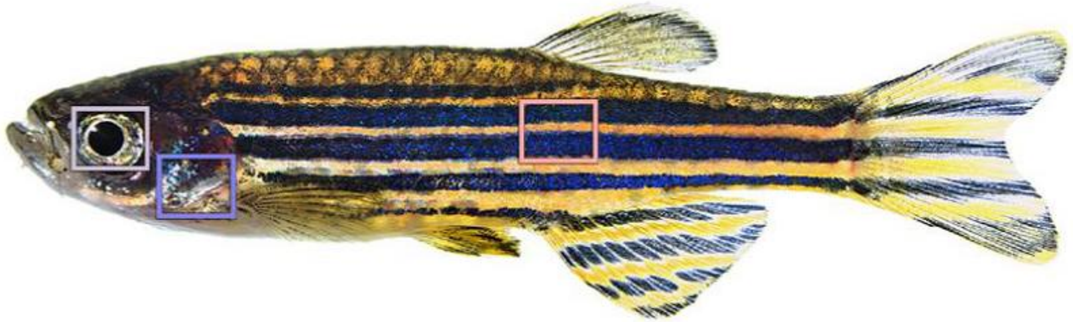


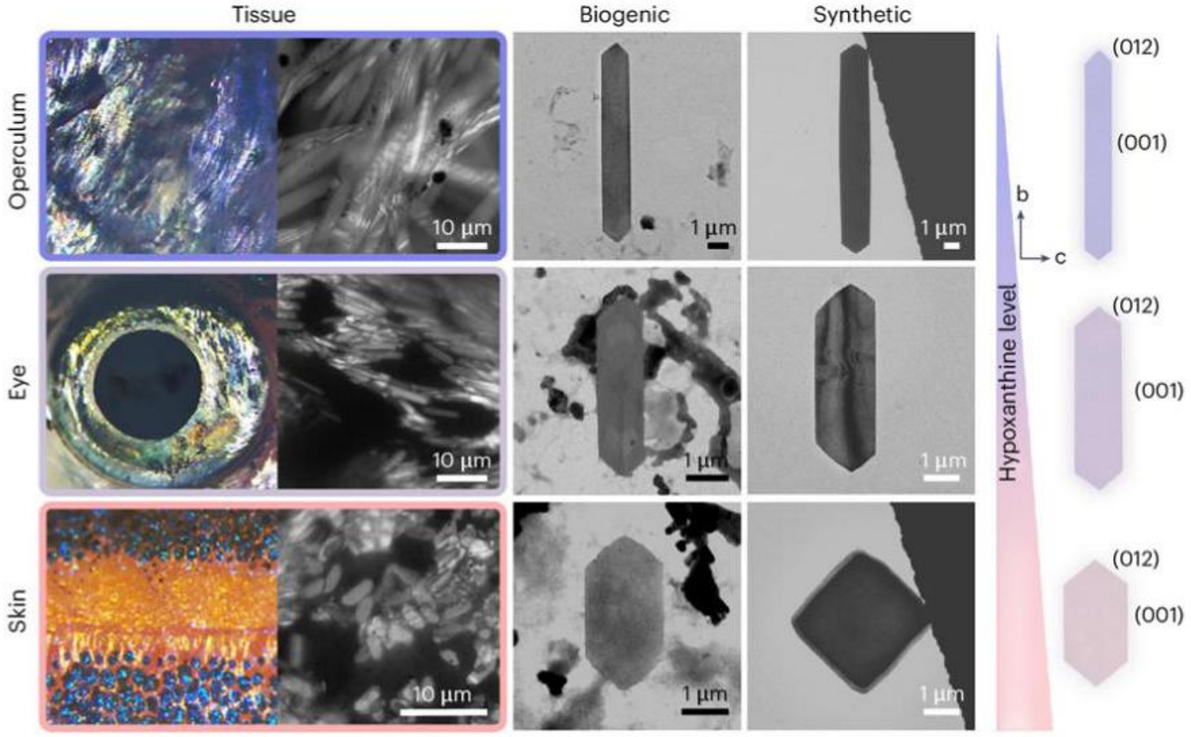




Dr. Keren Kahil, Prof. Lia Addadi and Prof. Steve Weiner, Chemical and Structural Biology Dept., WIS

Guanine crystals





nature chemical biology

Article

https://doi.org/10.1038/s41589-024-01722-1

Genetic control over biogenic crystal morphogenesis in zebrafish

Received: 26 January 2024

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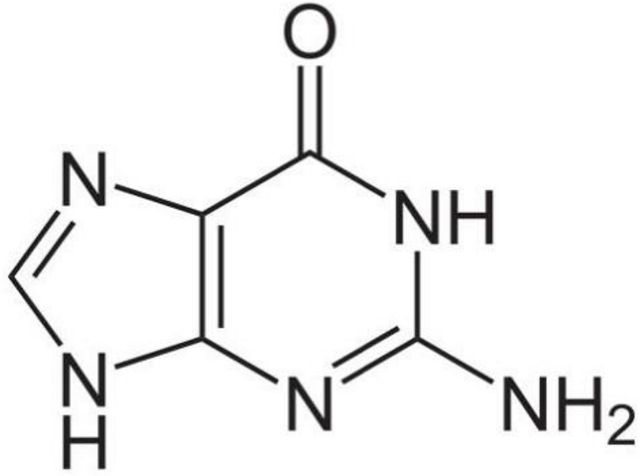
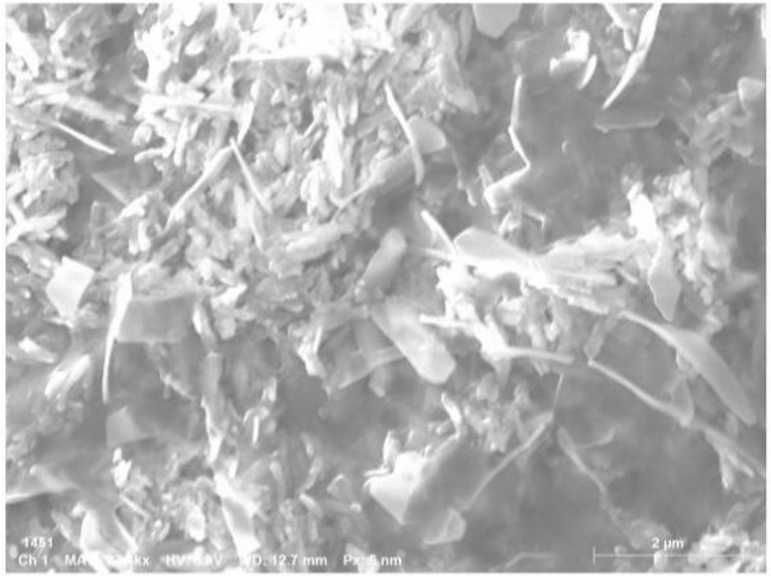
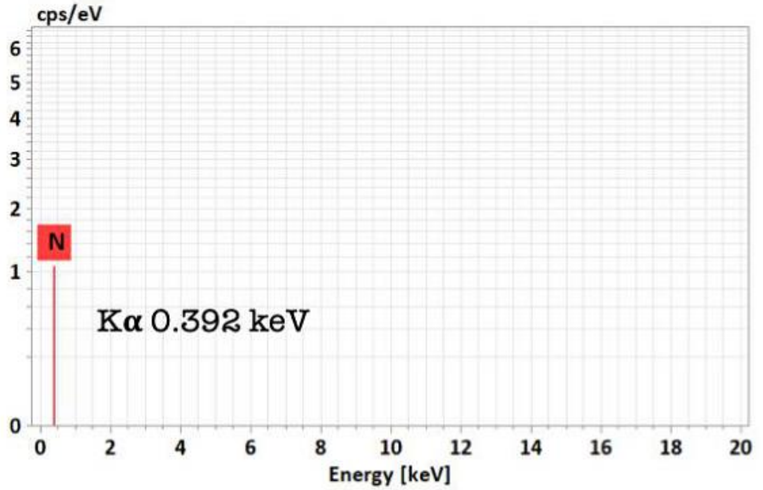
Check for updates

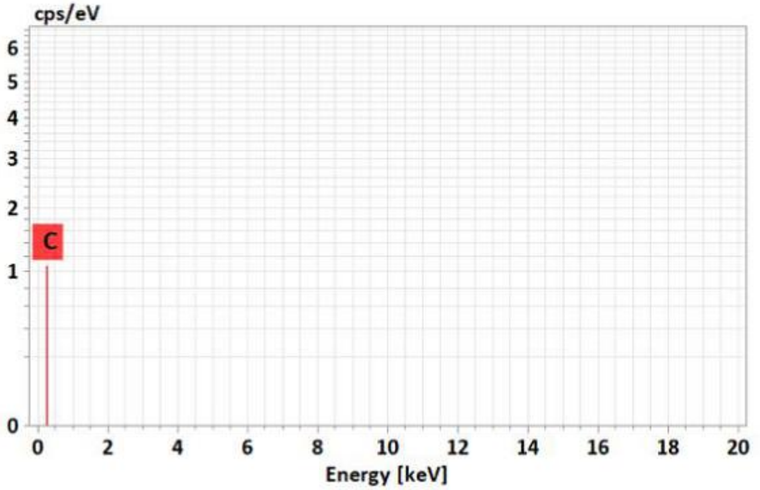
Rachael Deis[1], Tali Lerer-Goldshtein[1], Olha Baiko[1], Zohar Eyal[1], Dolev Brenman-Begin[1], Moshe Goldsmith[2], Sylvia Kaufmann[3,4], Uwe Heinig[5], Yonghui Dong[5], Sofya Lushchekina[6], Neta Varsano[7], Tsviya Olender[1], Meital Kupervaser[8], Ziv Porat[5], Smadar Levin-Zaidman[7], Iddo Pinkas[7], Rita Mateus[3,4] & Dvir Gur[1]



Guanine crystals

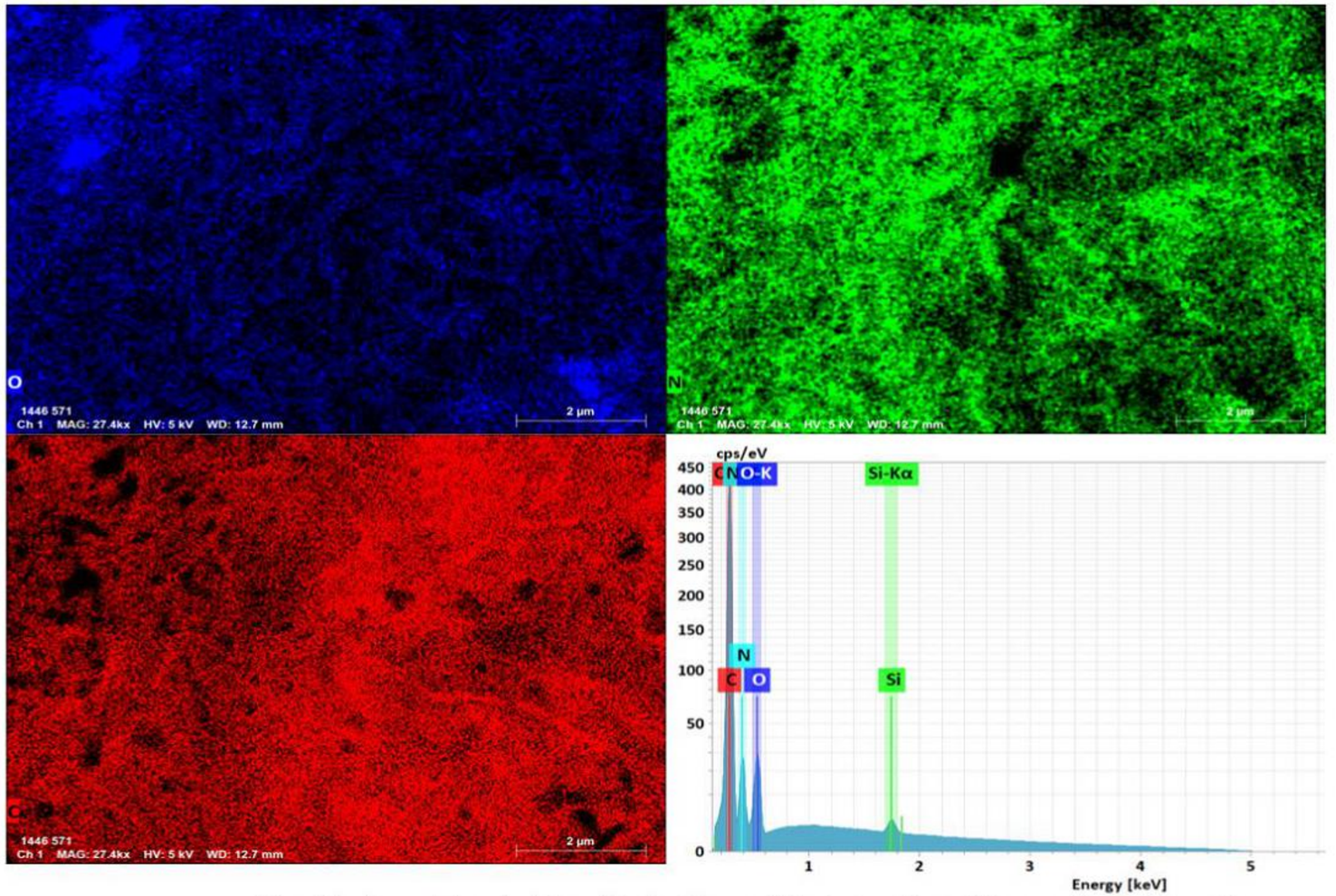






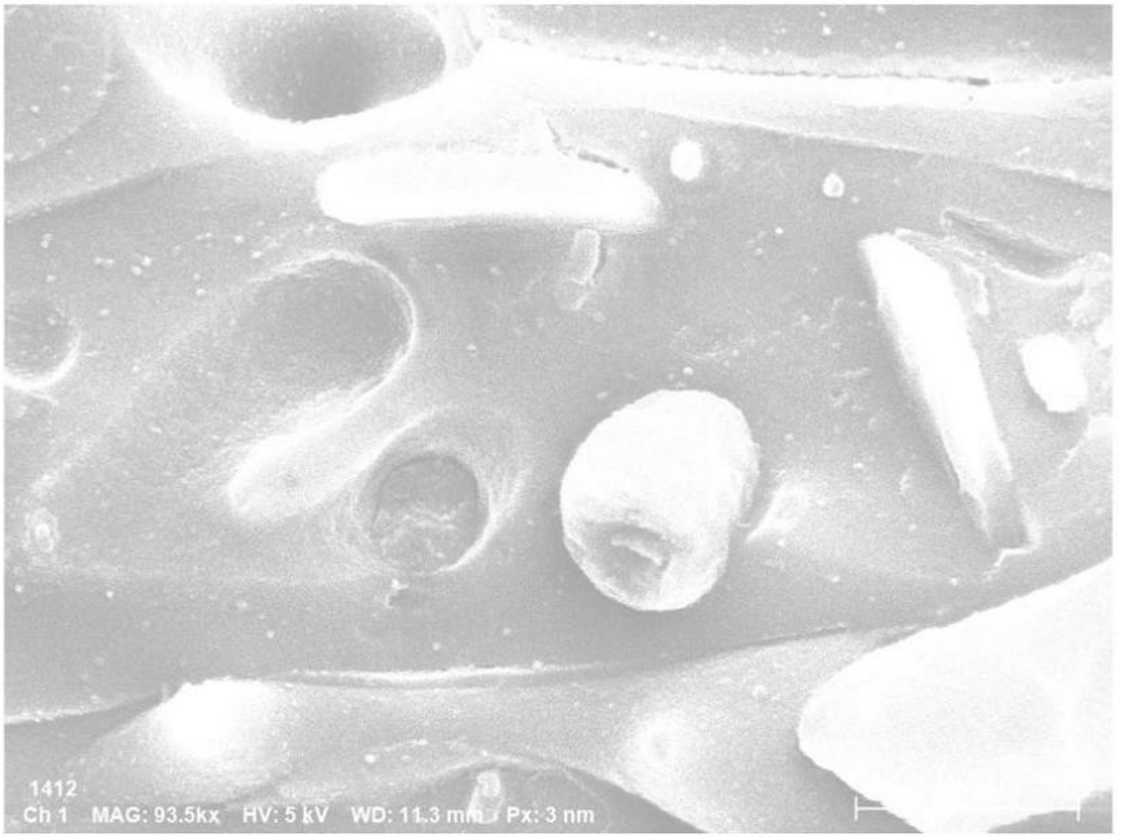
Dr. Zohar Eyal, Dr. Dvir Gur, Molecular Genetics Dept.

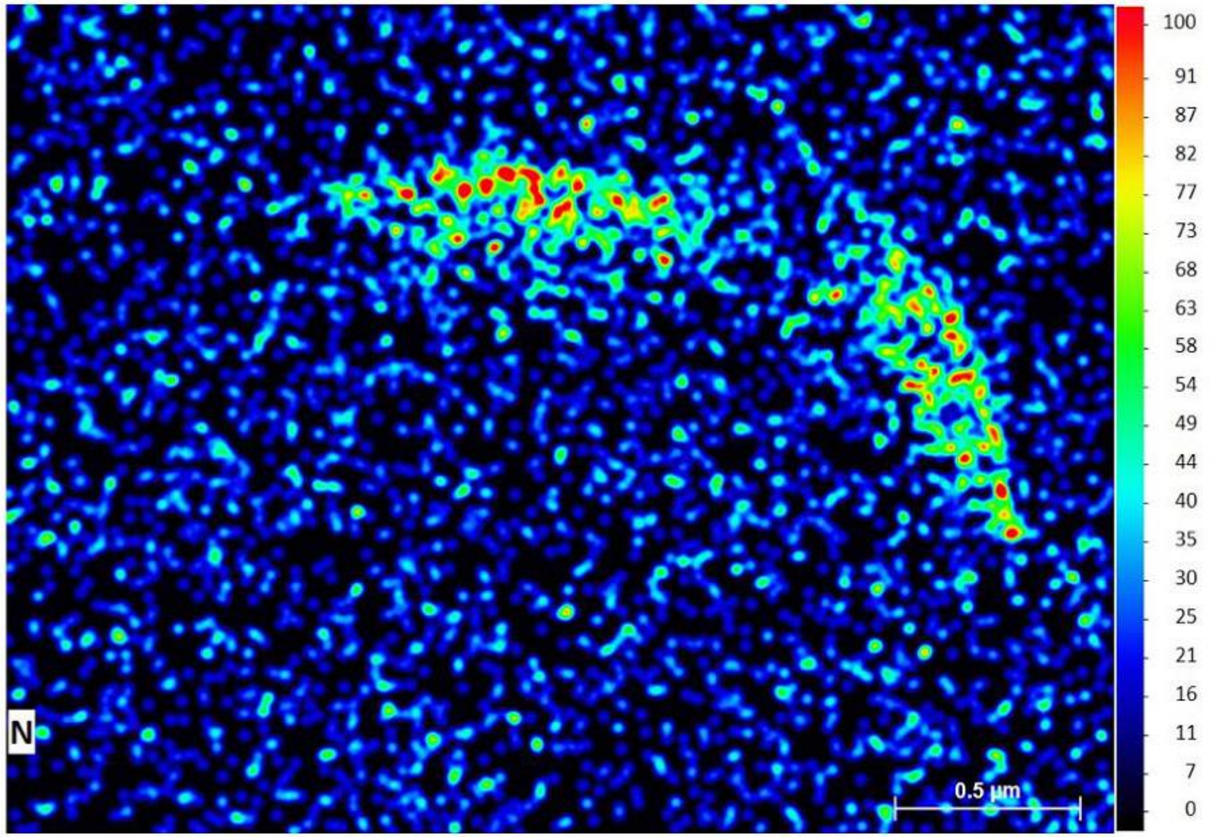
Guanine crystals



Dr. Zohar Eyal, Dr. Dvir Gur, Molecular Genetics Dept.

Cryo EDS of Guanine crystals





Dr. Zohar Eyal, Dr. Dvir Gur's Lab., Molecular Genetics Dept., WIS

Cryo EDS of silk fibers

nature communications

Article

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Metal ions guide the production of silkworm silk fibers

Received: 24 July 2023

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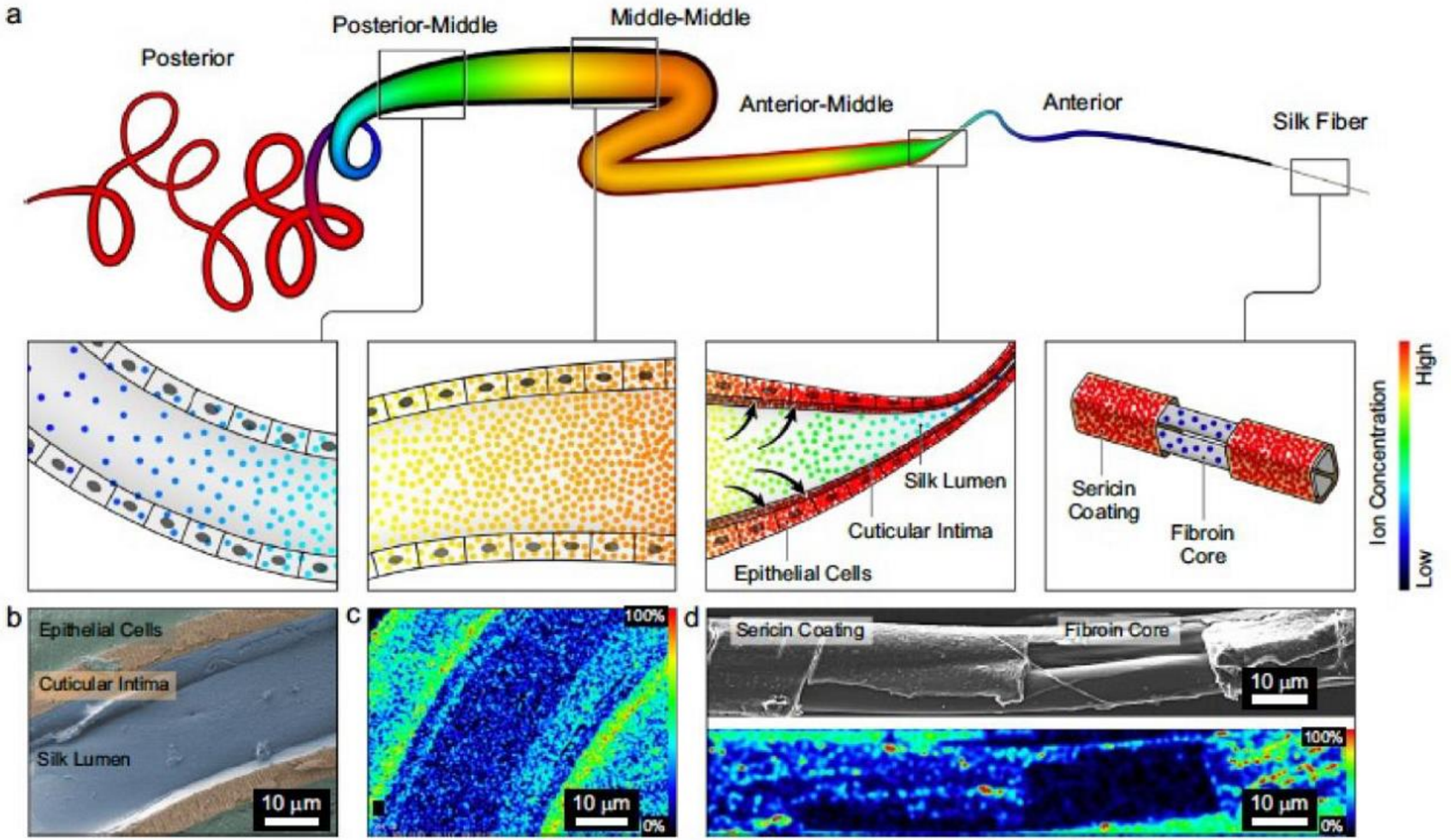
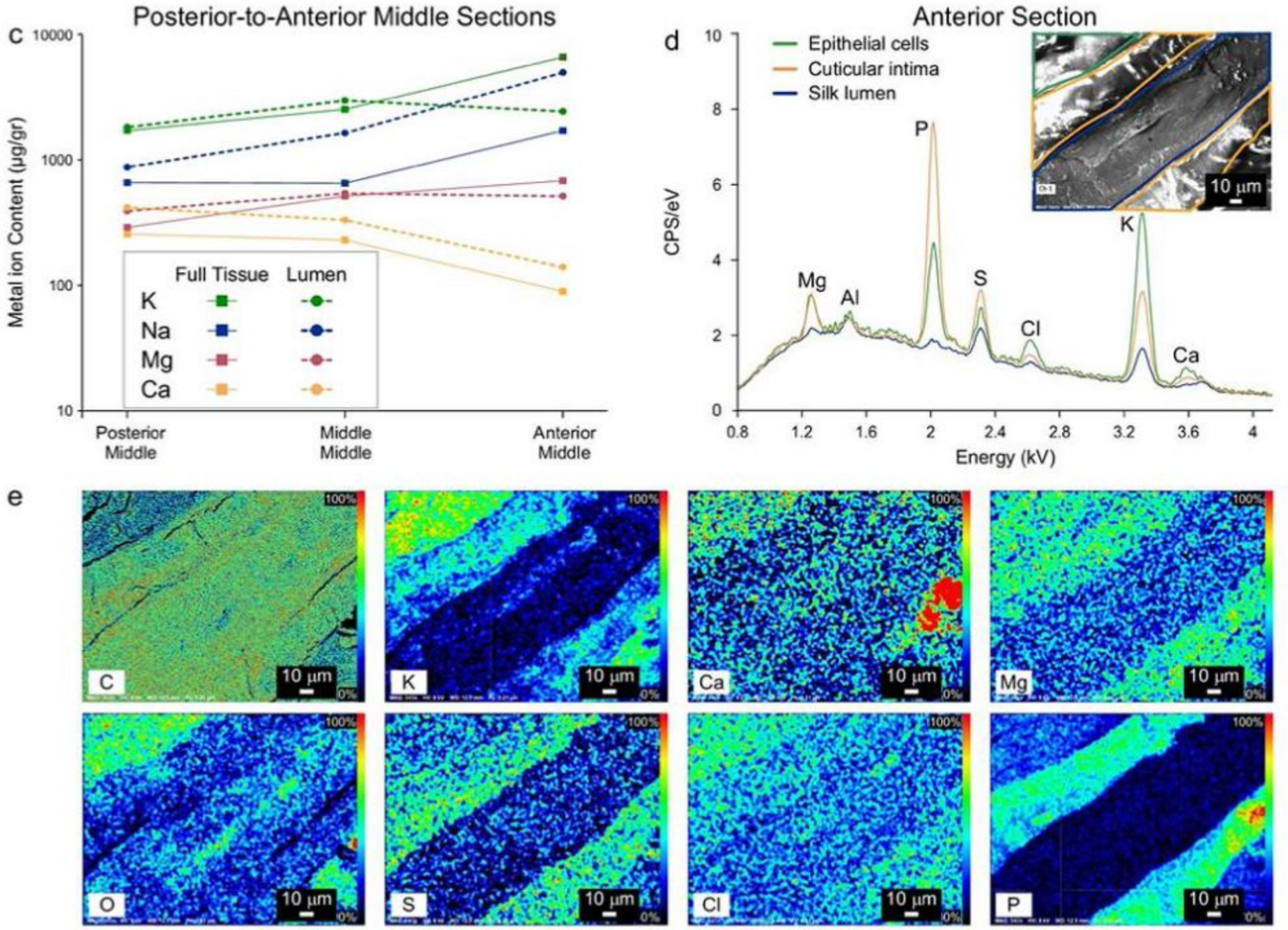
Ori Brookstein[1], Eyal Shimoni[2,4], Dror Eliaz[1], Ifat Kaplan-Ashiri[2], Itay Carmel[3] & Ulyana Shimanovich[1]

Metal ions guide the production of silkworm silk fibers



Ori Brookstein, Eyal Shimoni, Dror Eliaz, Ifat Kaplan-Ashiri, Itay Carmel & Ulyana Shimanovich, Nature Communications, (2024) 15:6671

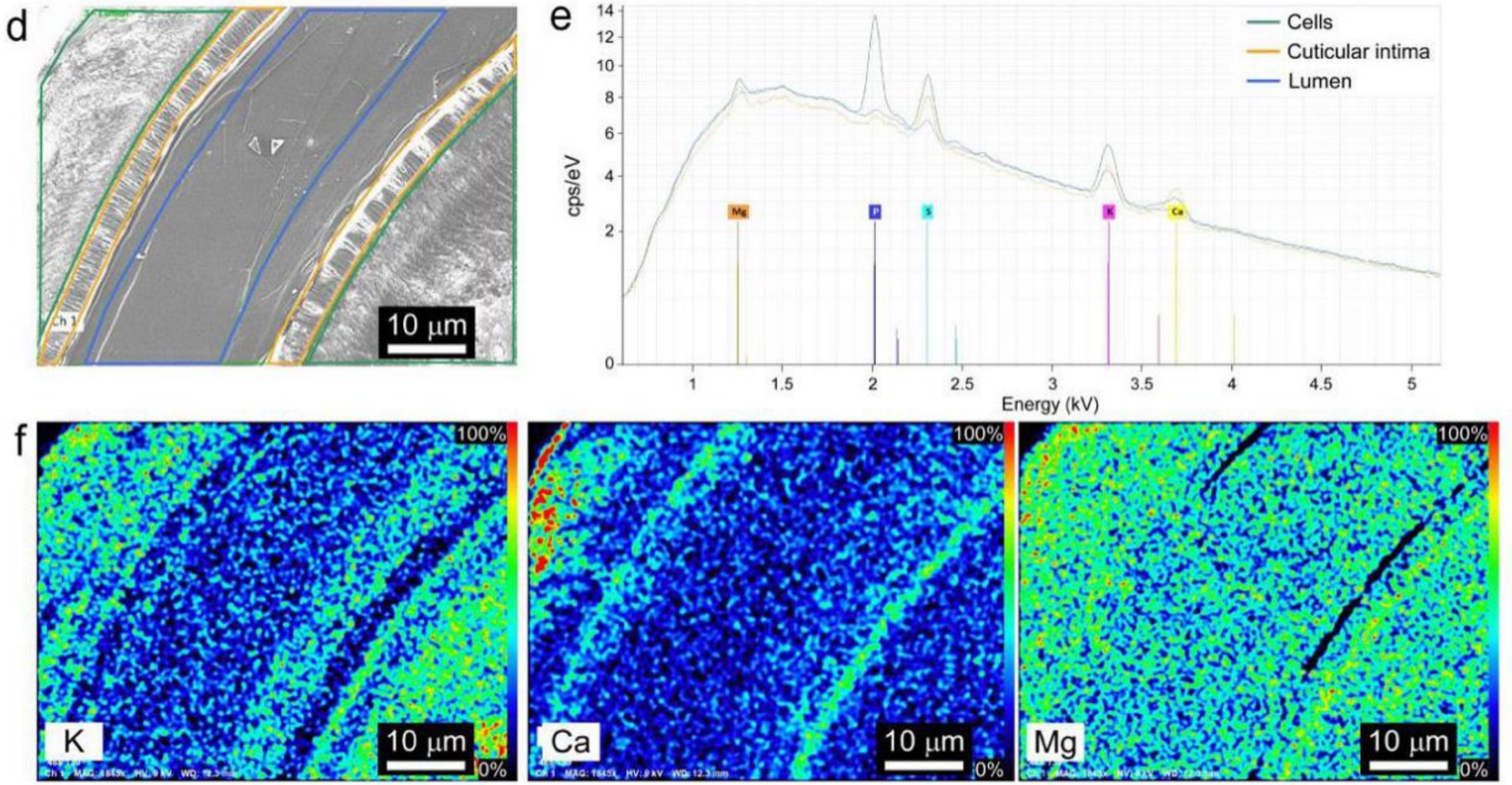
Metal ions guide the production of silkworm silk fibers



Concentration and distribution of elements along the silk spinning process

Ori Brookstein, Eyal Shimoni, Dror Eliaz, Ifat Kaplan-Ashiri, Itay Carmel & Ulyana Shimanovich, Nature Communications, (2024) 15:6671

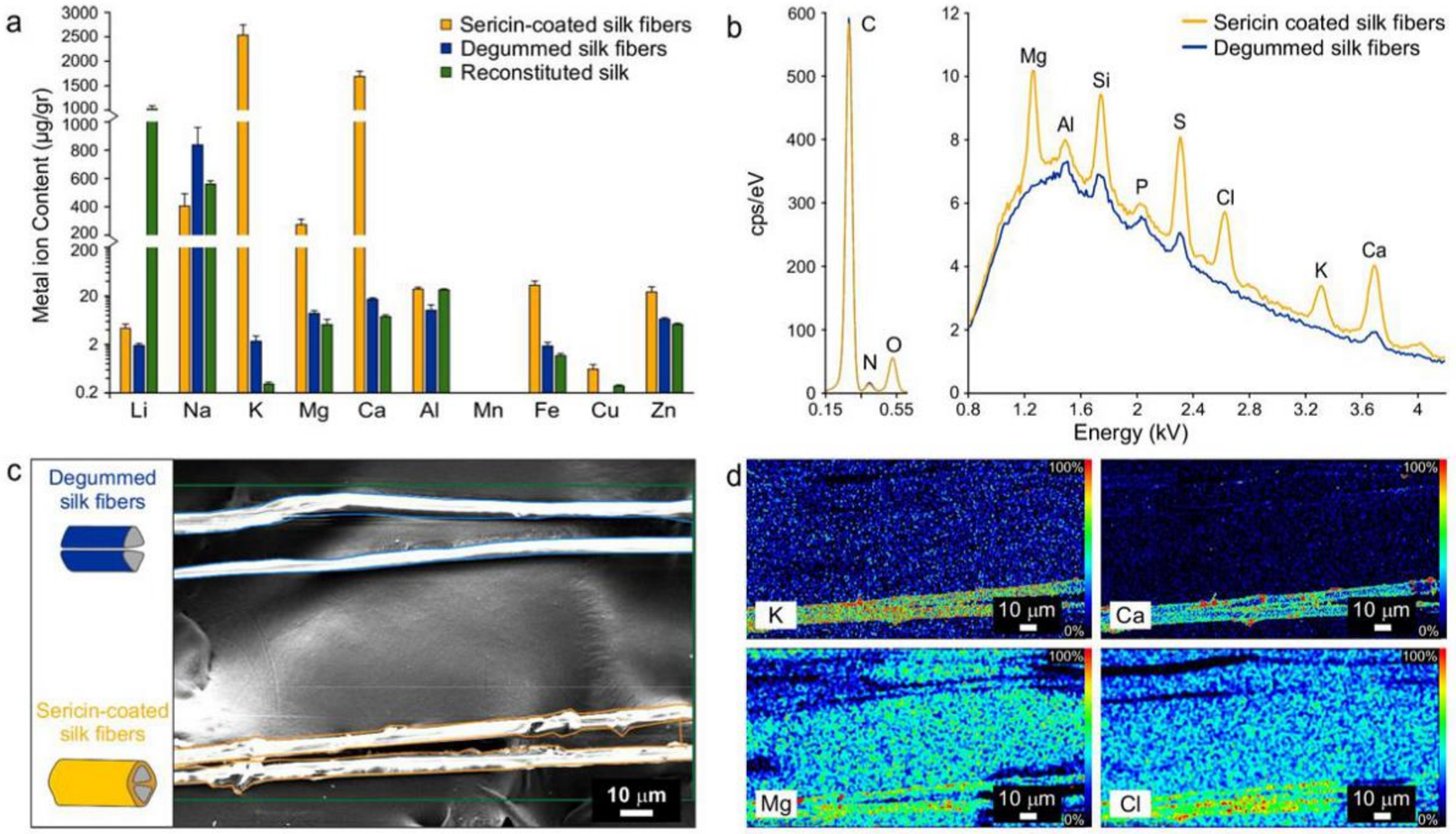
Metal ions guide the production of silkworm silk fibers



Metal ions distribution in the anterior section of the silk gland

Ori Brookstein, Eyal Shimoni, Dror Eliaz, Ifat Kaplan-Ashiri, Itay Carmel & Ulyana Shimanovich, Nature Communications, (2024) 15:6671

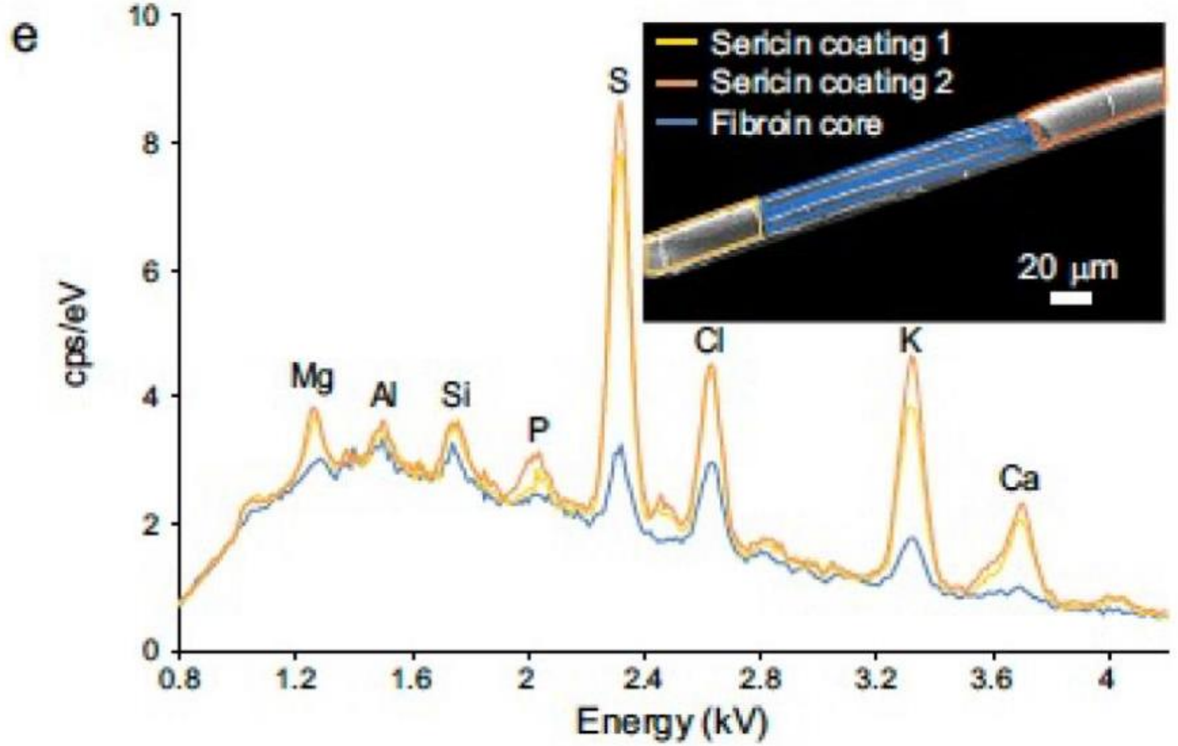
Metal ions guide the production of silkworm silk fibers

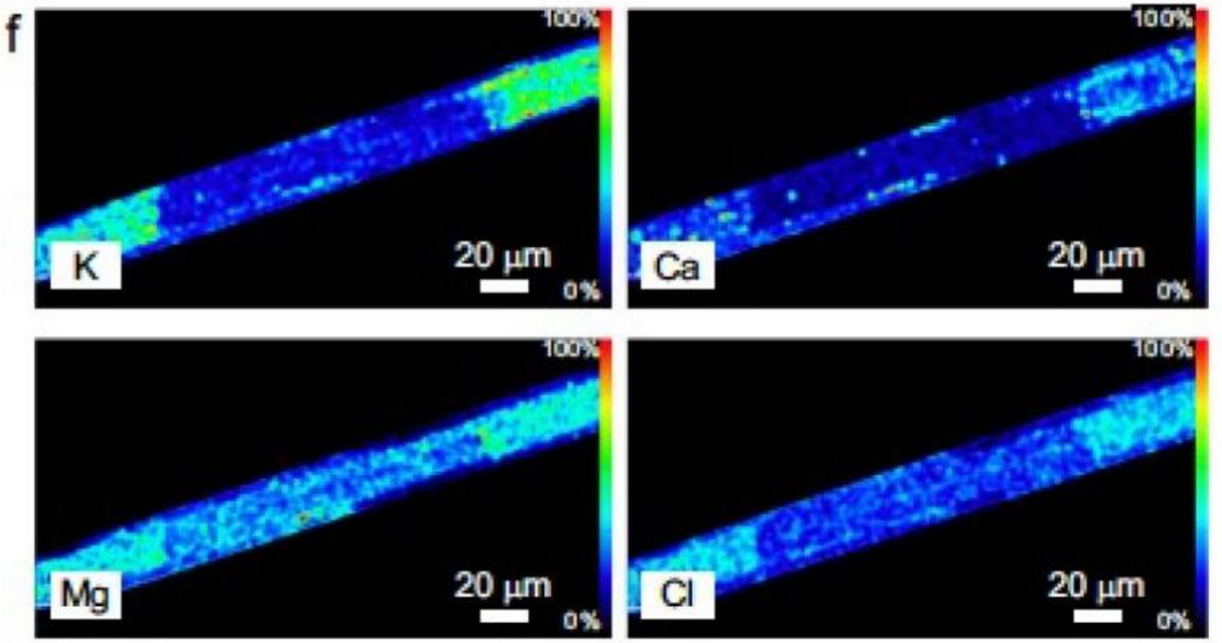


Metal ions in native and processed silk fibers

Ori Brookstein, Eyal Shimoni, Dror Eliaz, Ifat Kaplan-Ashiri, Itay Carmel & Ulyana Shimanovich, Nature Communications, (2024) 15:6671

Metal ions guide the production of silkworm silk fibers





Silk fiber with exposed fibroin core

Ori Brookstein, Eyal Shimoni, Dror Eliaz, Ifat Kaplan-Ashiri, Itay Carmel & Ulyana Shimanovich, Nature Communications, (2024) 15:6671

Summary

Cryo SEM EDS is a usefull technique to study local composition in various bilogical systems.

Every system requires the devlopment of the optimal workflow for SEM imaging and EDS acquisition.

Acknowledgments

EM Unit SEM team:
Dr. Neta Varsano
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Prof. Steve Weiner

Department of Molecular Chemistry and Materials Science
Dr. Ulyana Shimanovich
Ori Brookstein

Department of Molecular Genetics:
Dr. Dvir Gur
Dr. Zohar Eyal