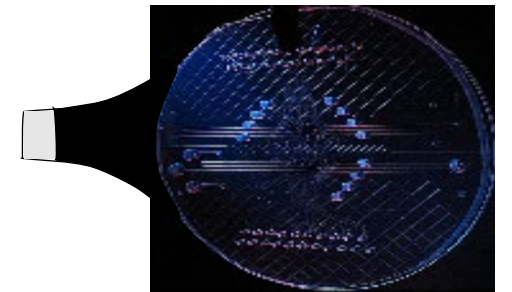


Preservation of DNA for Information Storage: DNA as Flash BioDrives

Devasier Bennet, Kellys Morara and Frederic Zenhausern*



Flash BioDrives

Introduction to Data storage:

- History of Data storage
- Why DNA is a candidate medium?
- DNA storage capacity, handling and stability?

Methods:

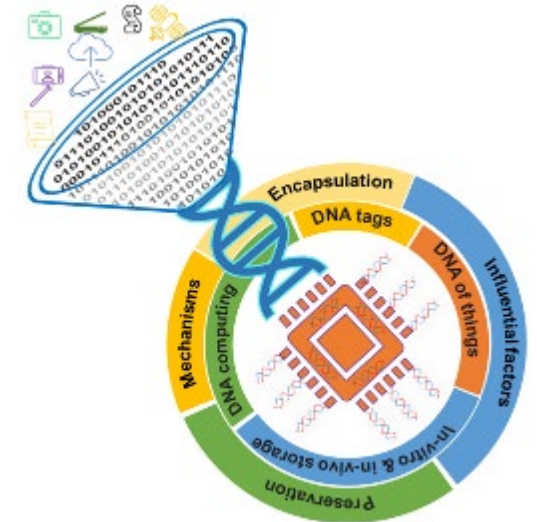
- Synthetic DNA Data and gDNA Preparation
- Xanthan Gum Framework-Encoded biomimetic Mineralization of Calcium Phosphate
- DNA encapsulation

Results and discussions:

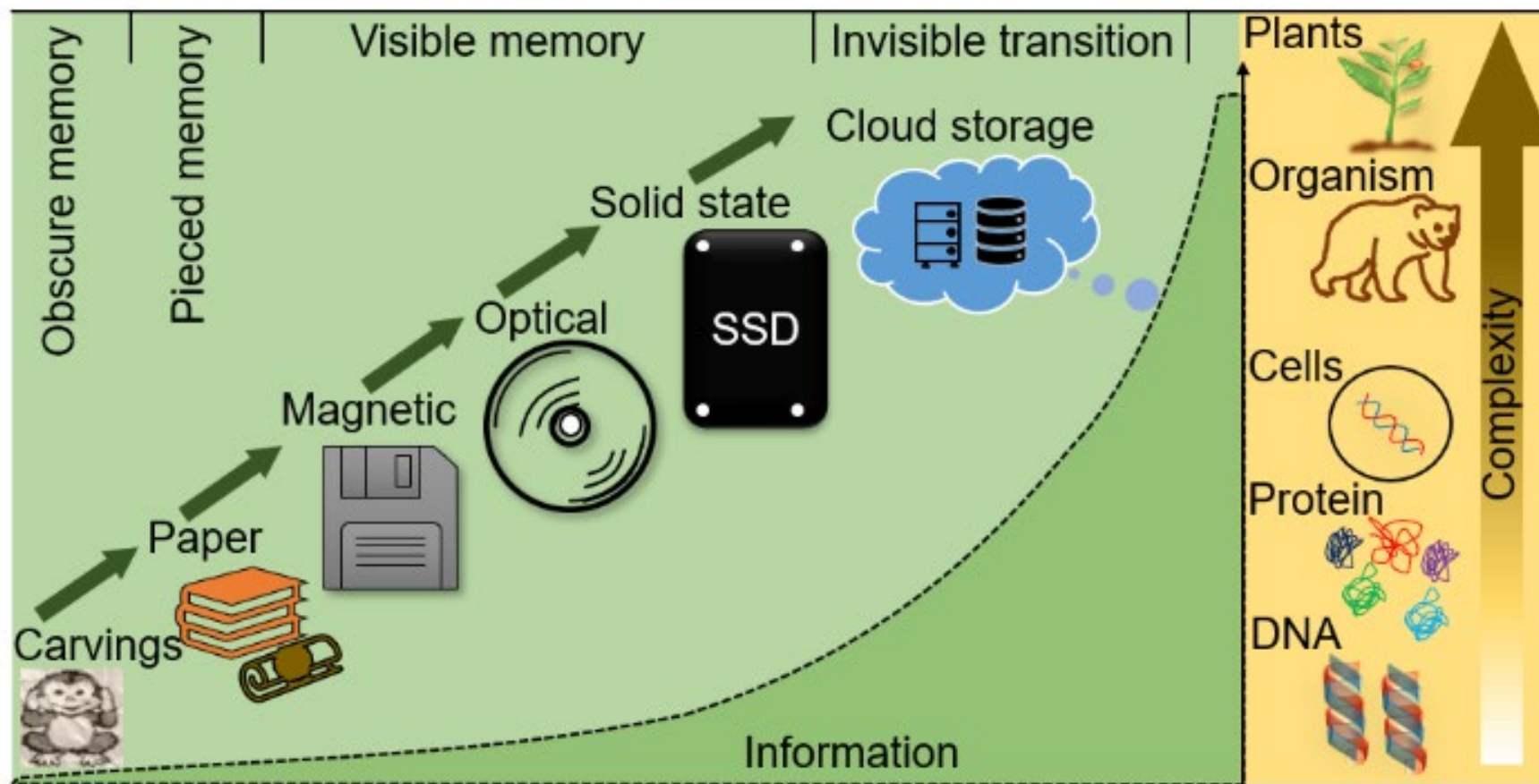
- Characterizations by AFM, XRD, fluorescent microscopy and optical microscopy
- DNA Damage Analysis

Future Works:

- End-to-end programmable write-to-store-to-read cycle of data





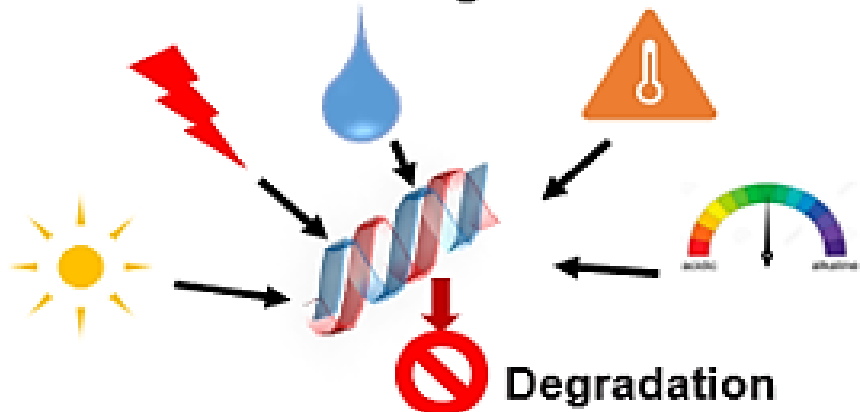


History of Storage Methods

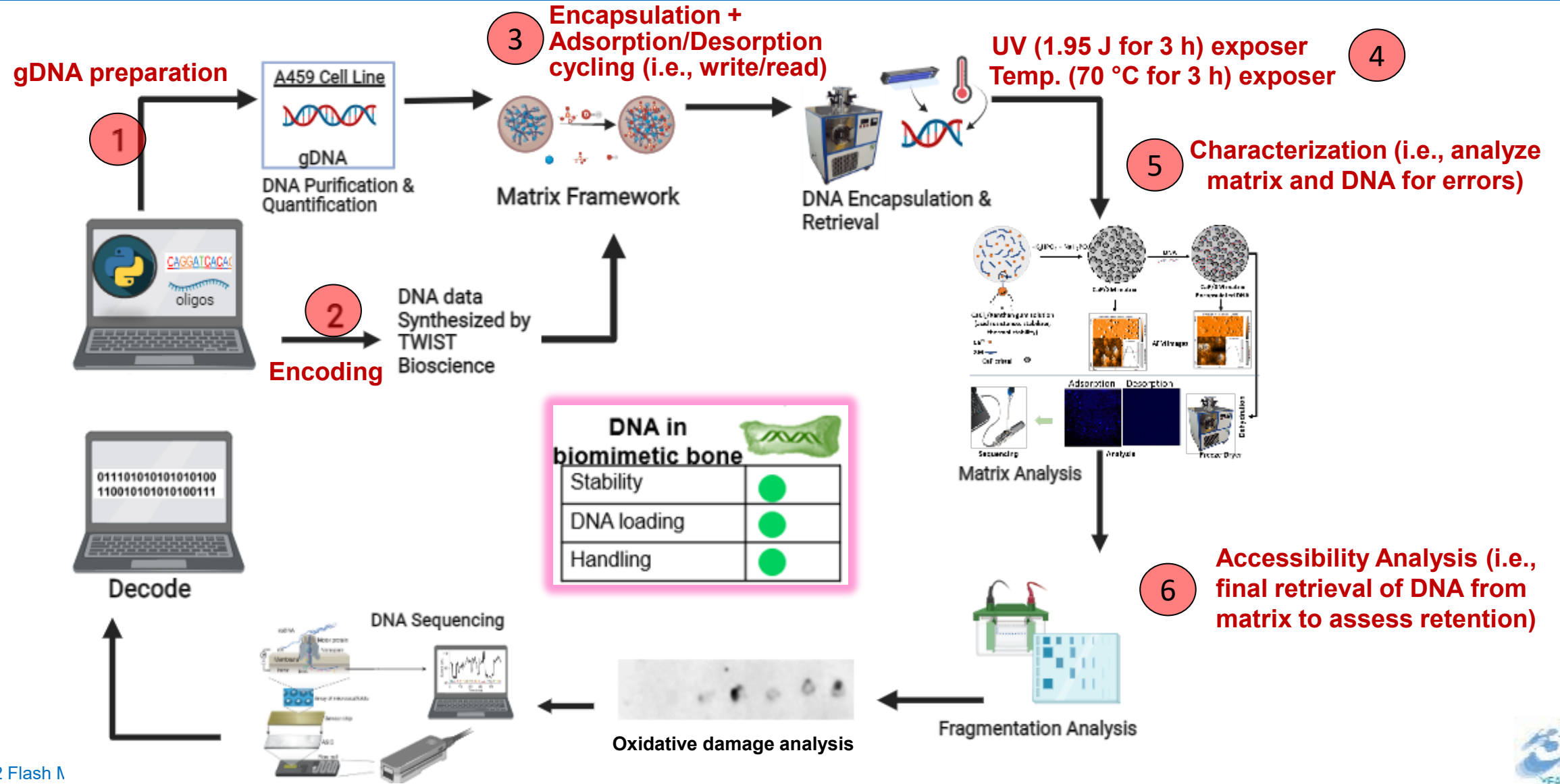


Historical progress of storage mediums over time

Current Preservation Techniques

Current storage				
	DNA in bone	DNA in solution	DNA in nanoparticle	DNA in salt
				
Stability	●	●	●	●
DNA Loading	●	●	●	●
Handling	○	●	●	●
Color code: ● = high, ● = medium, ● = low, No current DNA storage media is optimal in all aspects				
Influence factors of DNA degradation				
 <div>Degradation</div>				

Our workflow



1 & 2. DNA preparation and synthesis

1

gDNA extraction and purification:



Harvested



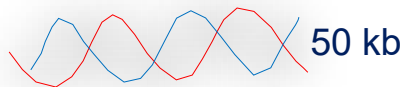
gDNA was isolated



Purified



Quantified



2

Synthetic DNA data:

Source file

“Inspiration four”



DNA Data Synthesis



Encoded Data using Python



TWIST Bioscience synthesized the Oligos
Nucleotides (64 nt)



Synthesized DNA oligos

CAGGATCACAGGATCACAGGATCACA GATCACAGGATCACAGGATC

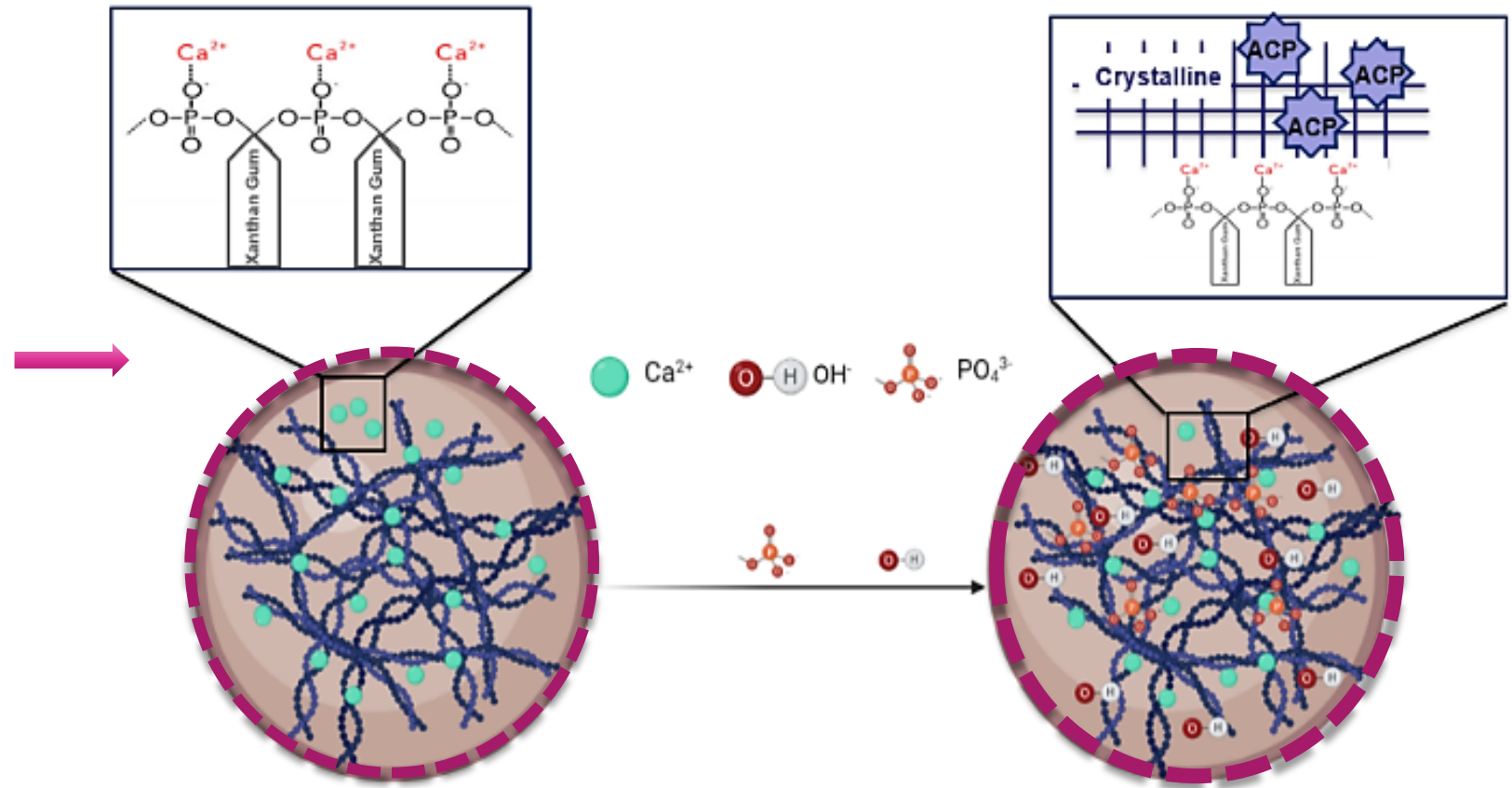
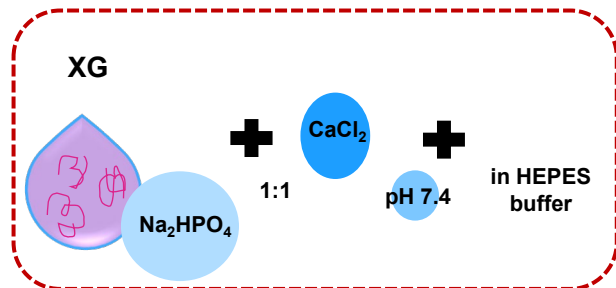


3. DNA preservation

A) Encapsulate DNA in matrix

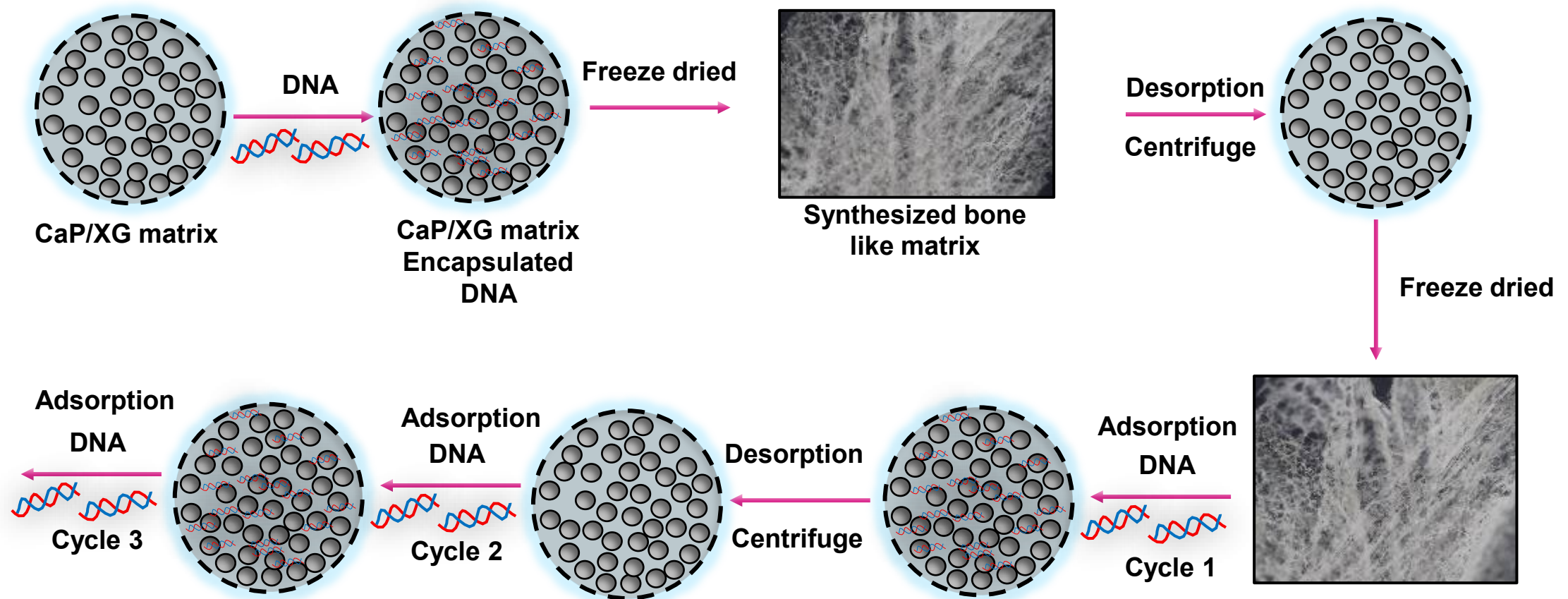
Xanthan Gum Framework-Encoded Mineralization of Calcium Phosphate

Mineralization process



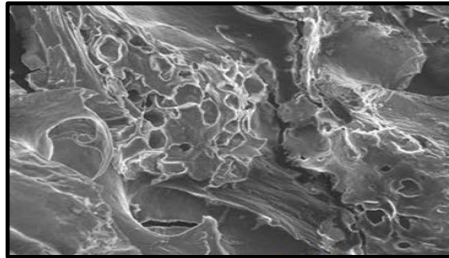
3. DNA preservation

B) Adsorption/desorption cycling (i.e., write/read)



4. Expose DNA in encapsulated matrix to environmental effects

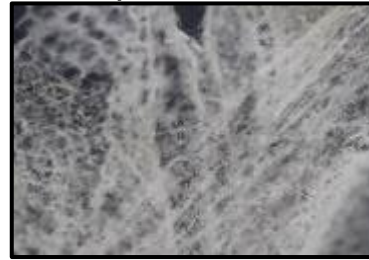
Bone matrix



Emami et al. J Transl Med (2020) 18:361

DSLR camera
captured images

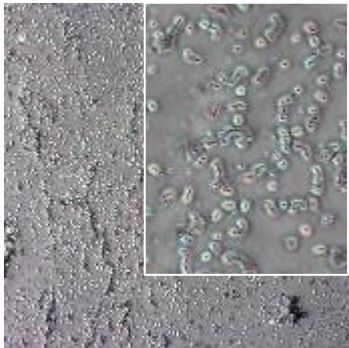
UV exposed
synthesized DNA Data
encapsulated matrix



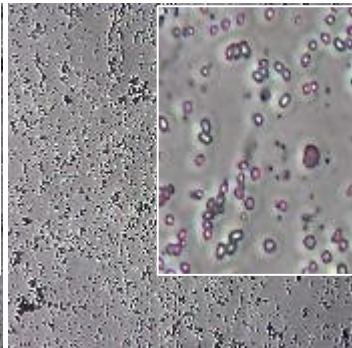
Temp. exposed
synthesized DNA Data
encapsulated matrix



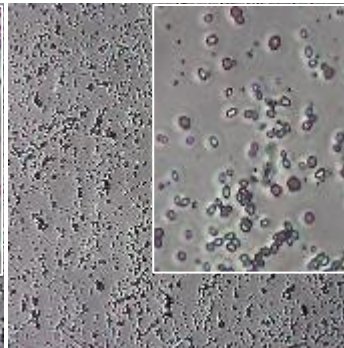
Control (No DNA
encapsulated matrix)



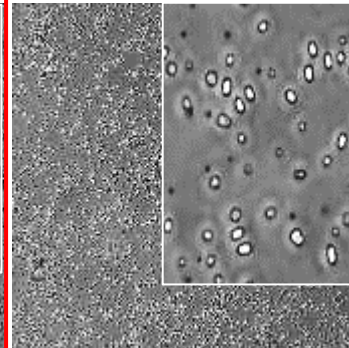
Synthesized DNA Data
encapsulated matrix



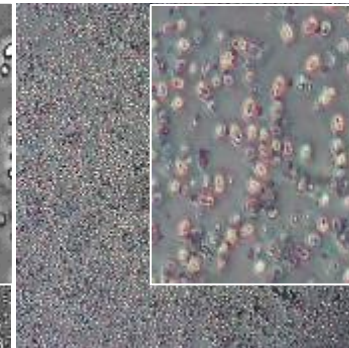
gDNA encapsulated
matrix



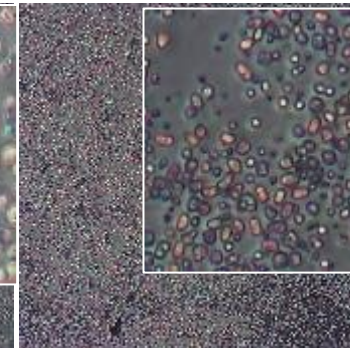
UV (1.95 J) exposed
synthesized DNA data
encapsulated matrix



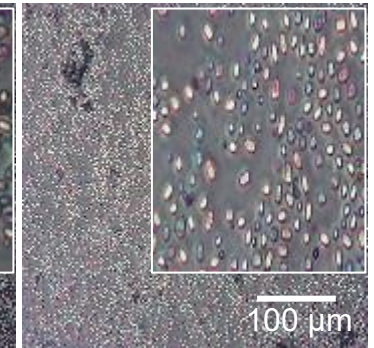
Temp. (70 °C) exposed
synthesized DNA data
encapsulated matrix



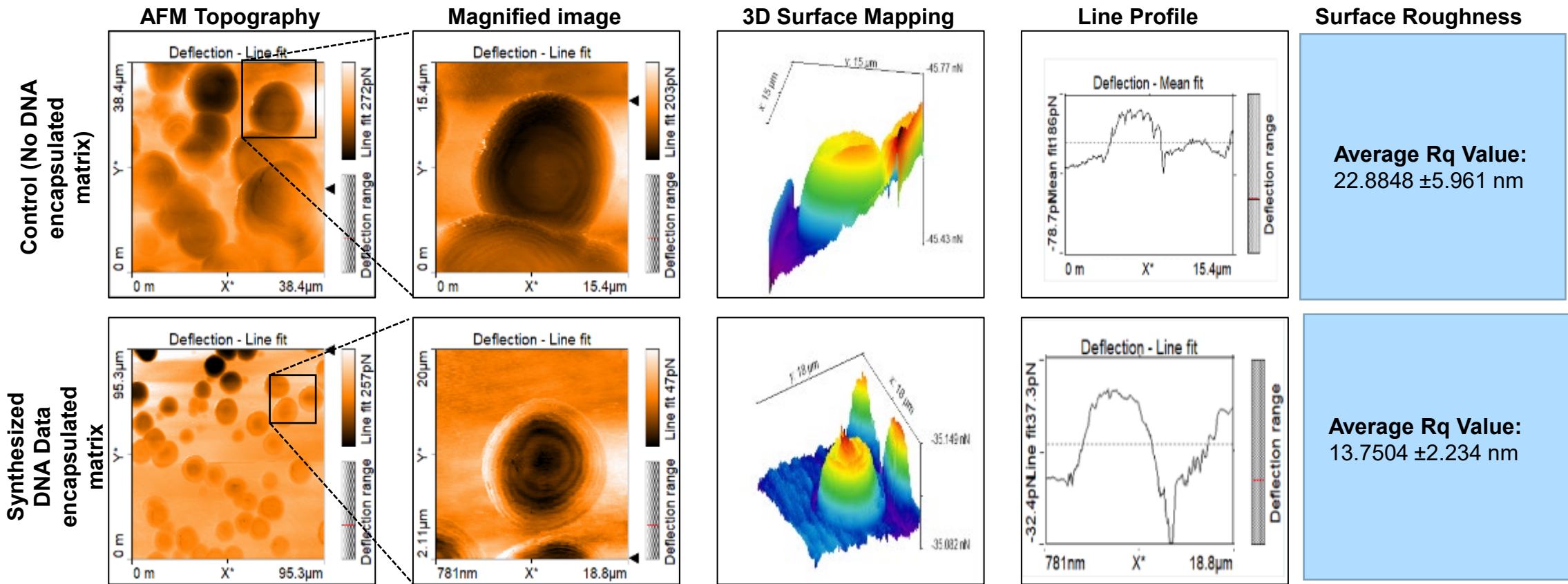
UV exposed gDNA
encapsulated matrix



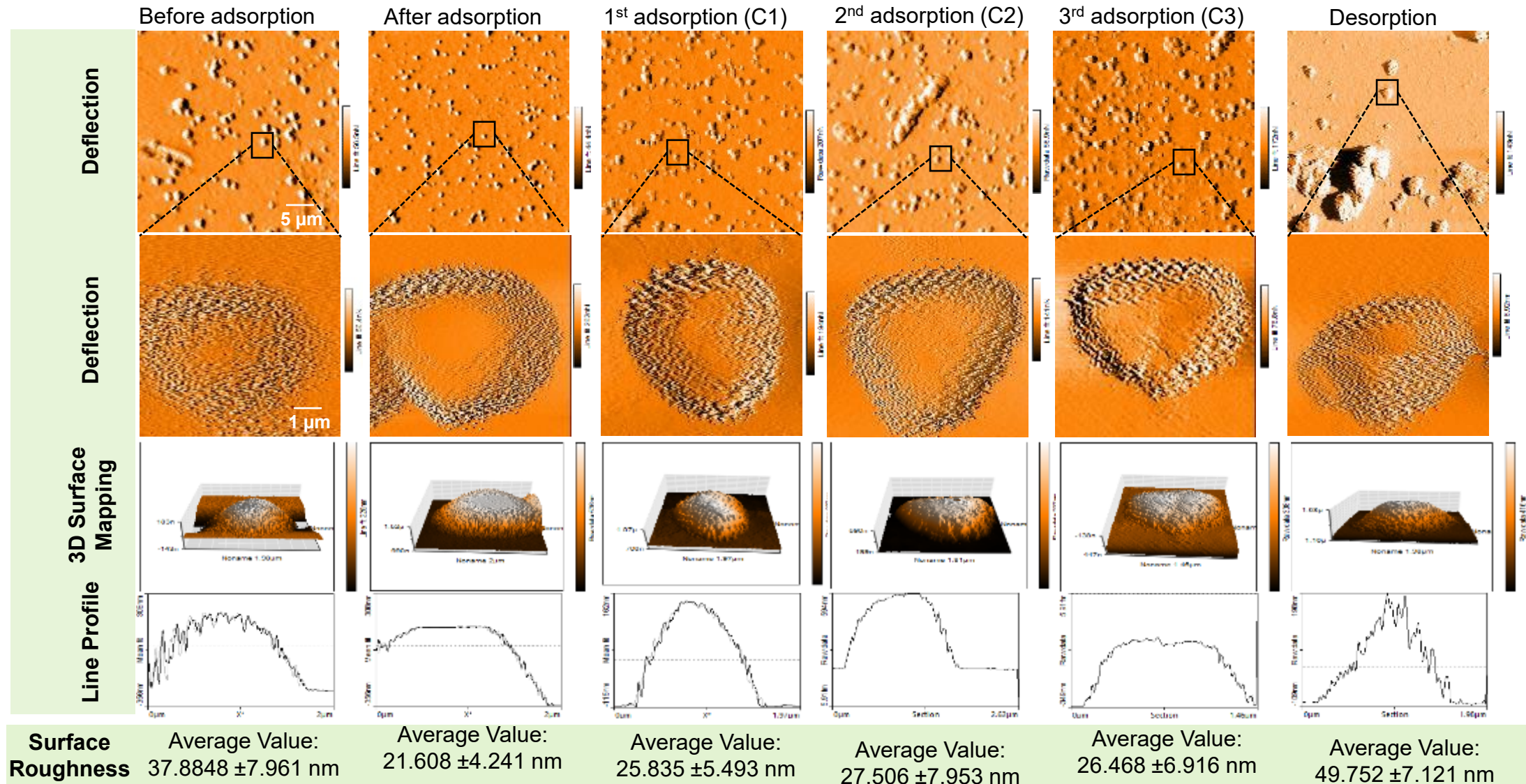
Temp. exposed gDNA
encapsulated matrix



5. A) Characterization of synthetic DNA data encapsulation



5. B) Characterization of gDNA adsorption/desorption cycle



6. Accessibility

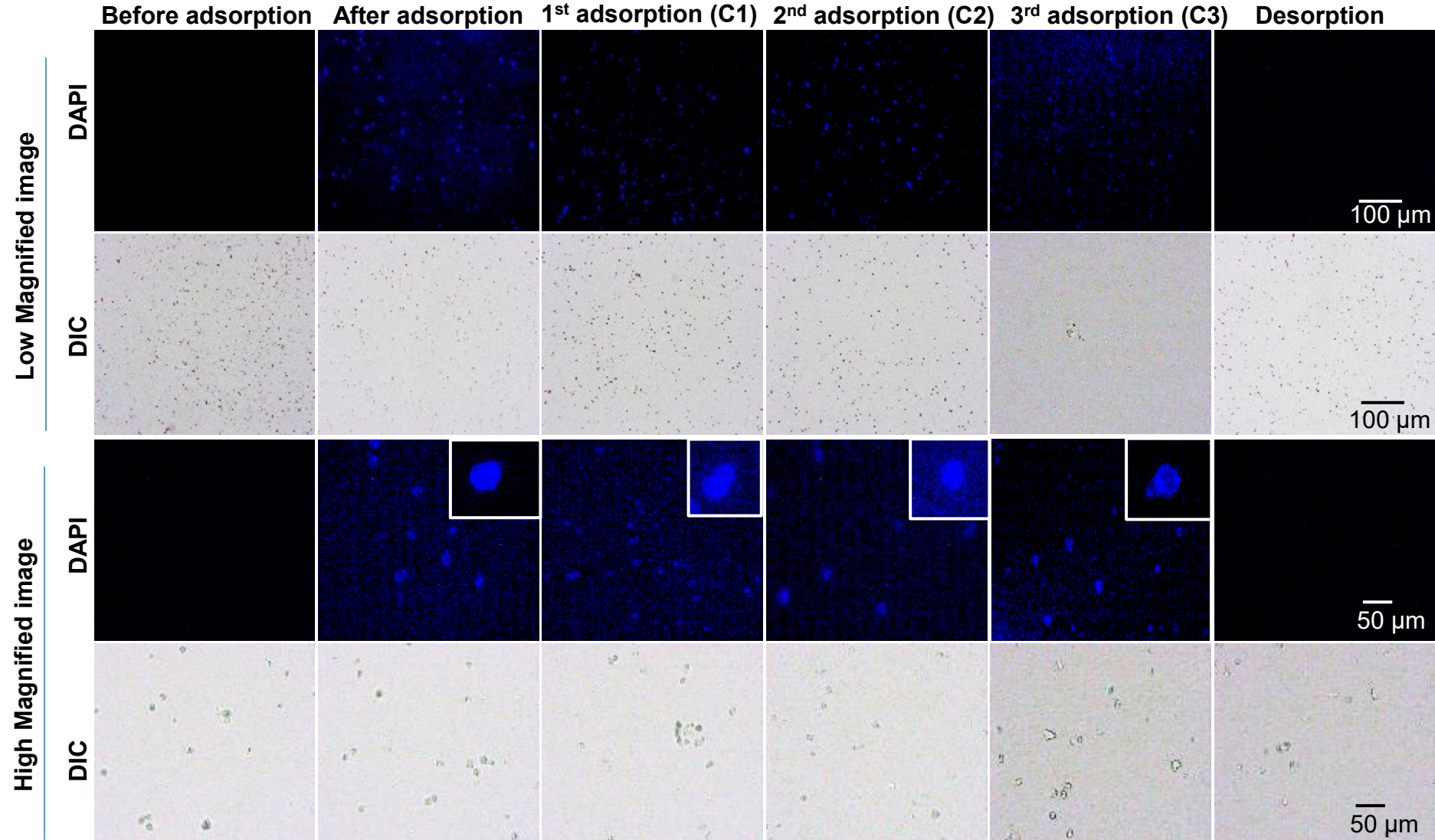
A) Adsorption and Desorption efficiency



DNA DATA
STORAGE
ALLIANCE
A SNIA Technology Affiliate

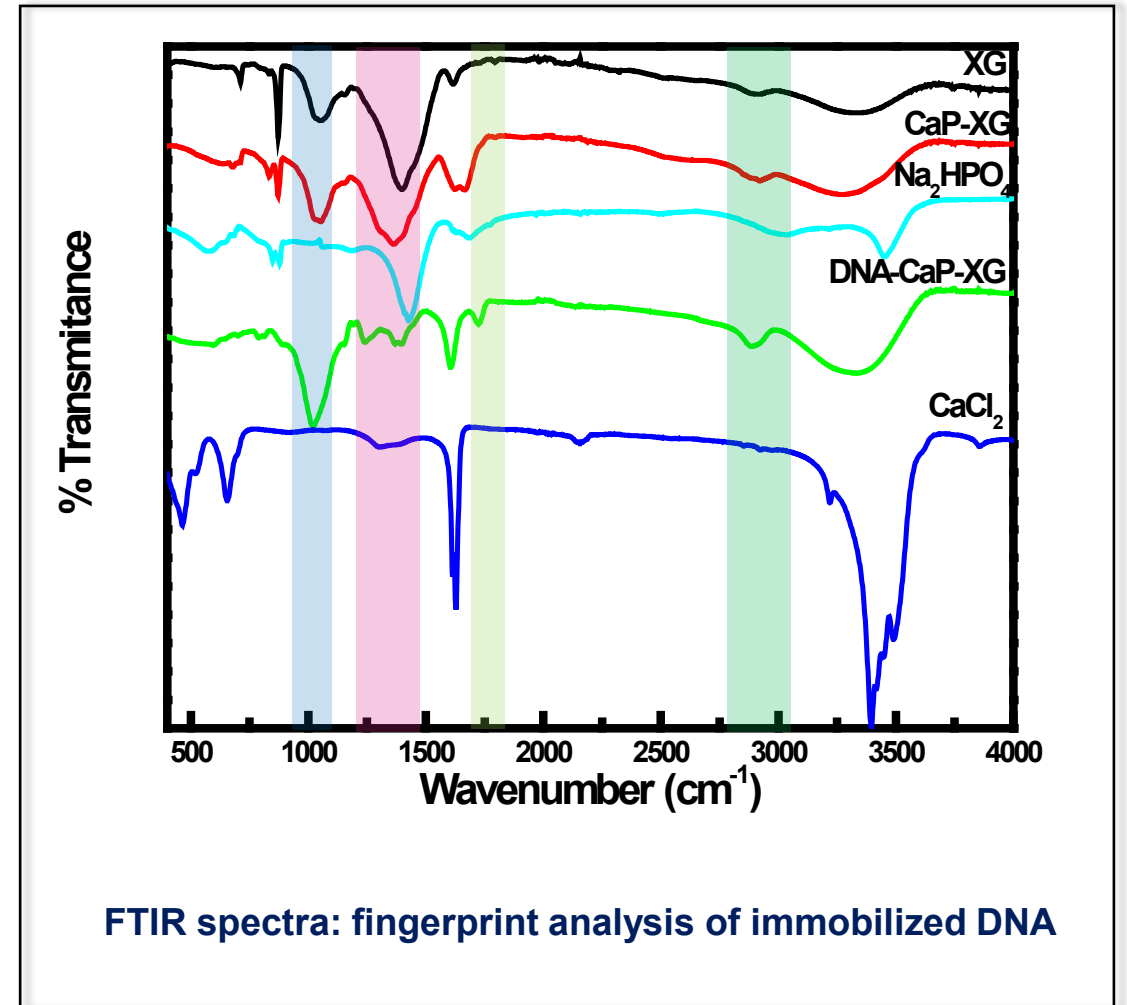
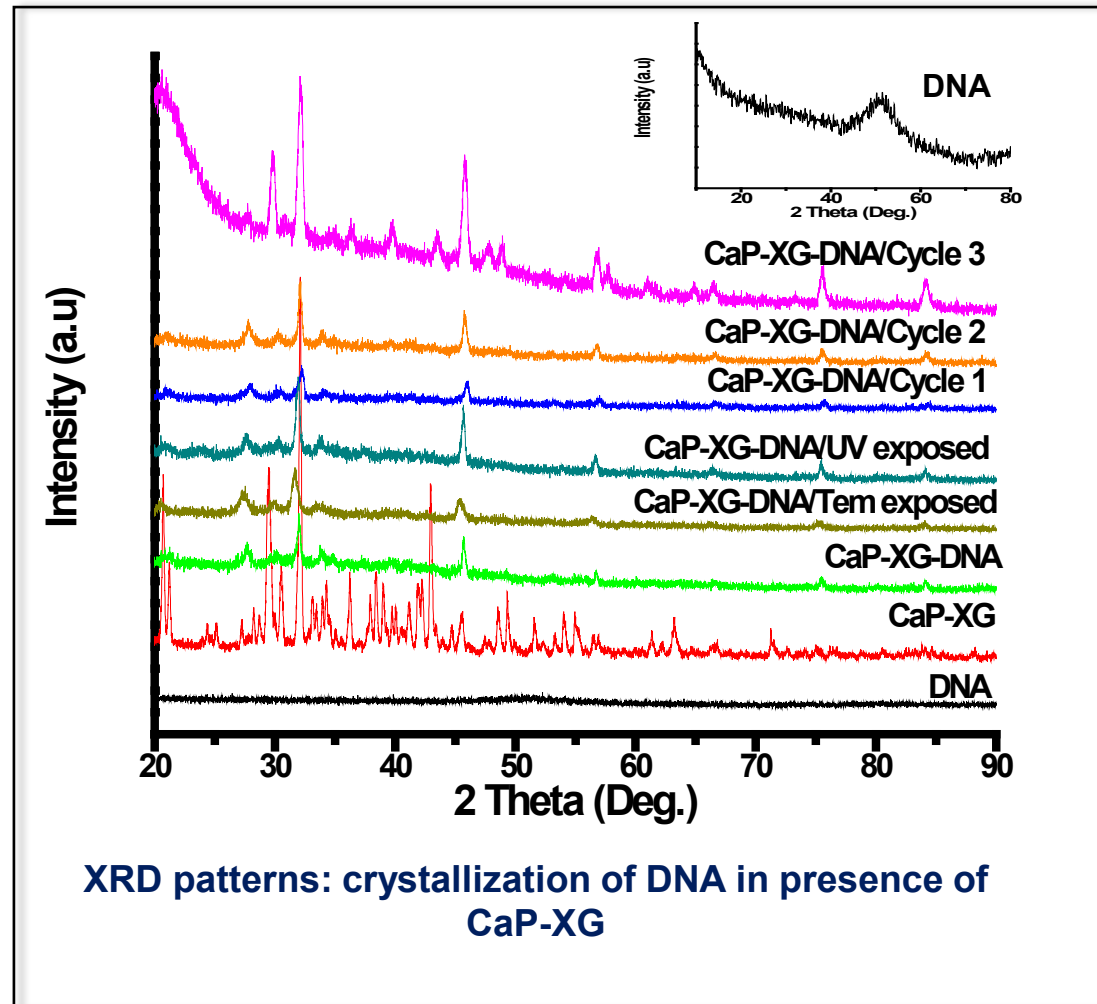


Flash Memory Summit



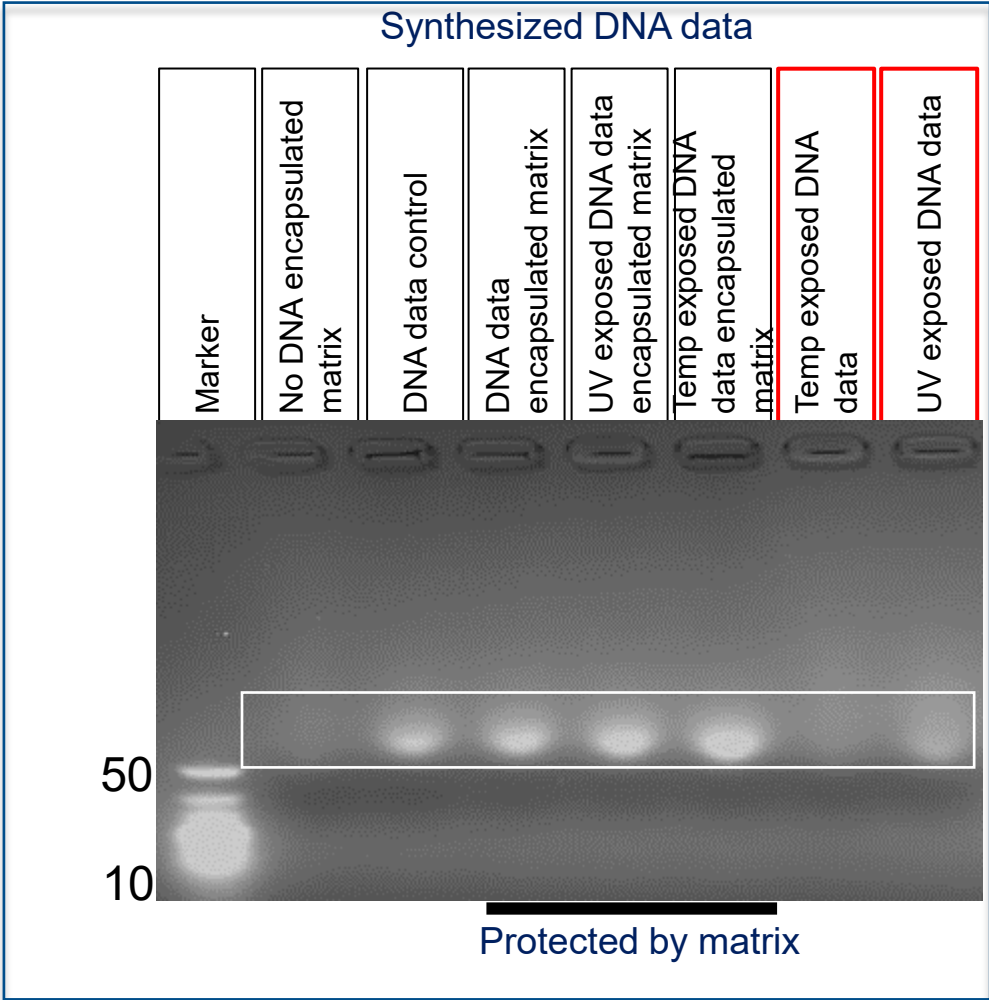
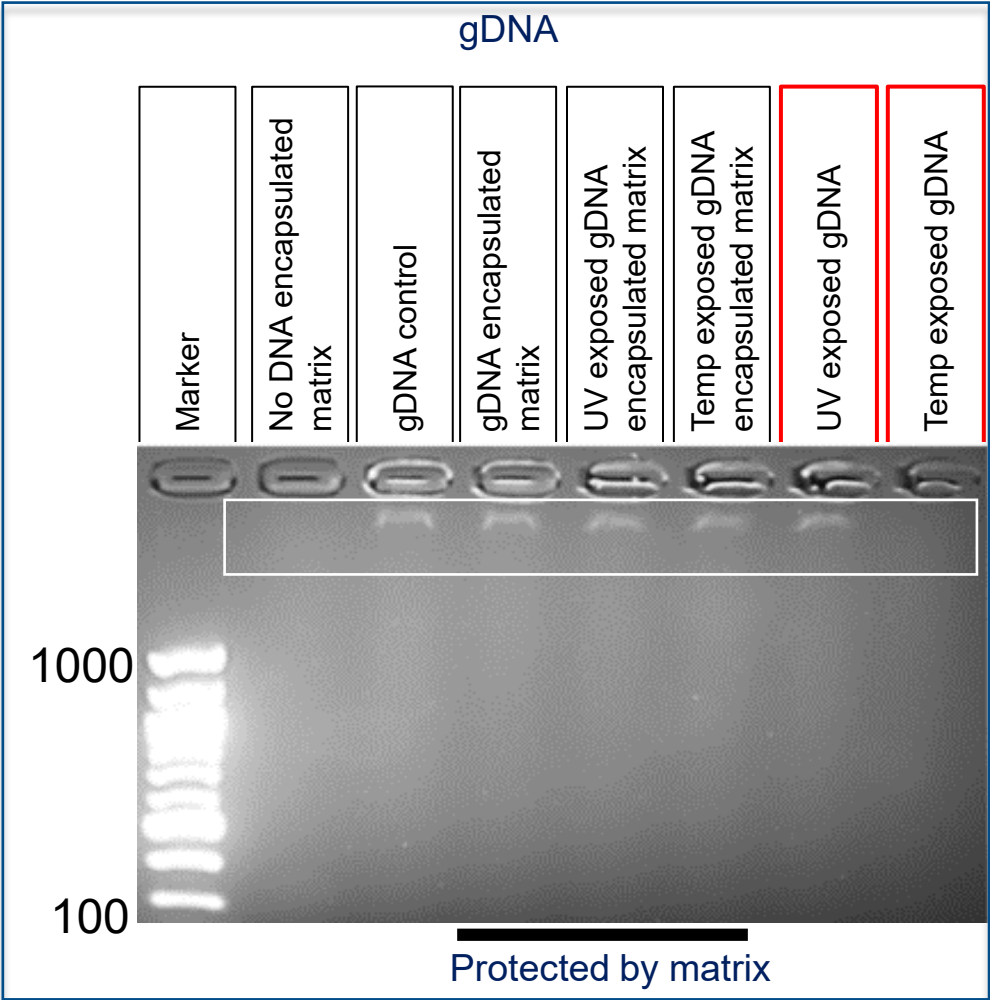
6. Accessibility

B) Medium stability



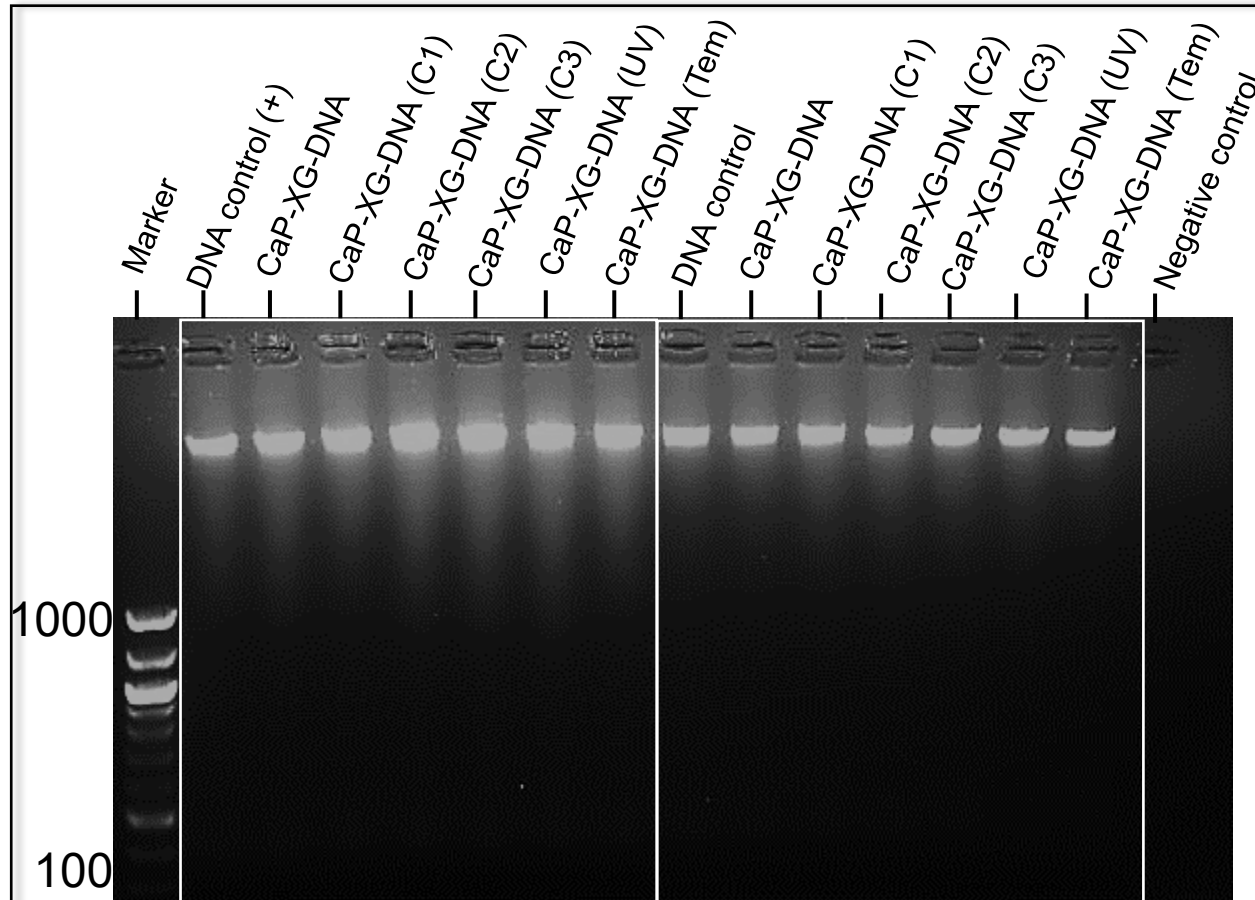
6. Accessibility

C) DNA Fragmentation/denaturation

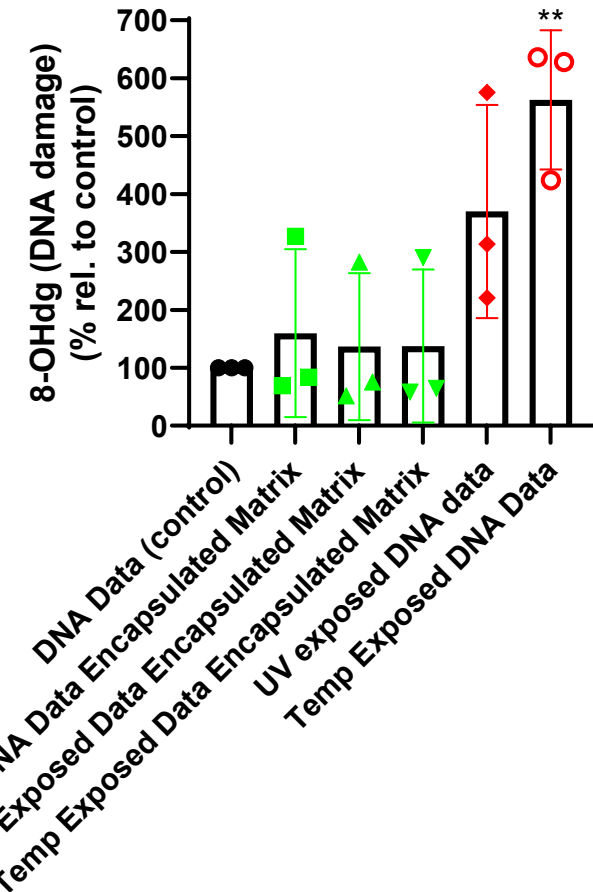


6. Accessibility

D) Analysis of fragmentation/denaturation and oxidative damage



Gel electrophoresis analysis of the DNA

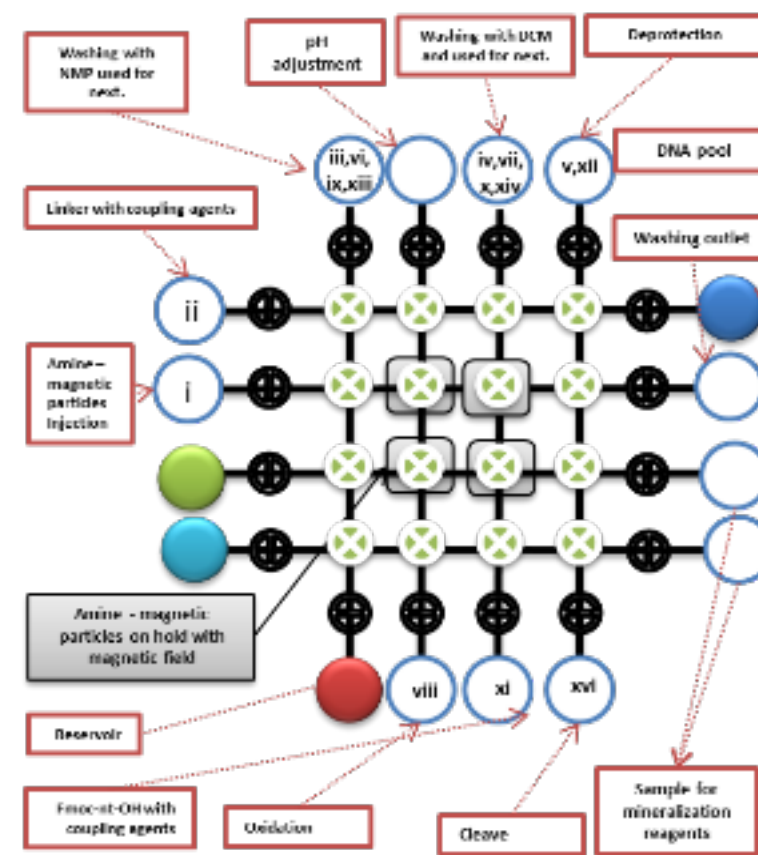
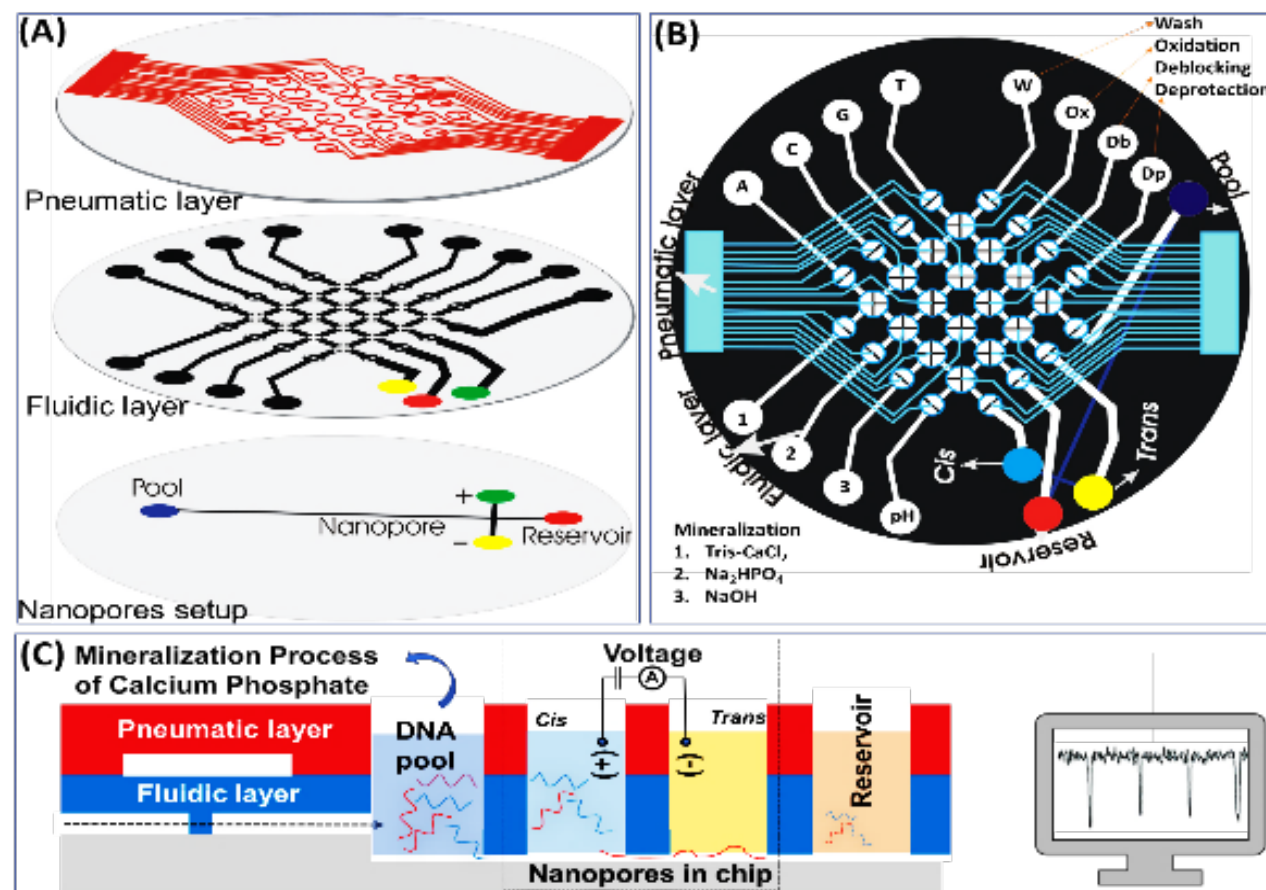


A Dot immunobinding assay was conducted to check the level of oxidation within each encoded data sample.

Future Work

Application to PMP

End-to-end programmable automated DNA storage device (write to store to read cycle of data)



Summary

- Successfully encode data using Python
- Successfully extracted DNA from human cell line
- Successfully created preservation medium that has a high loading capacity, stable, and easy to handle
- Encapsulated the synthetic DNA Data and gDNA
- Successfully characterized the matrix
- Conducted fragmentation analysis
- Conducted oxidative and temperature damage analysis

Acknowledgements

A sincere thanks to everyone who made this opportunity and project possible.

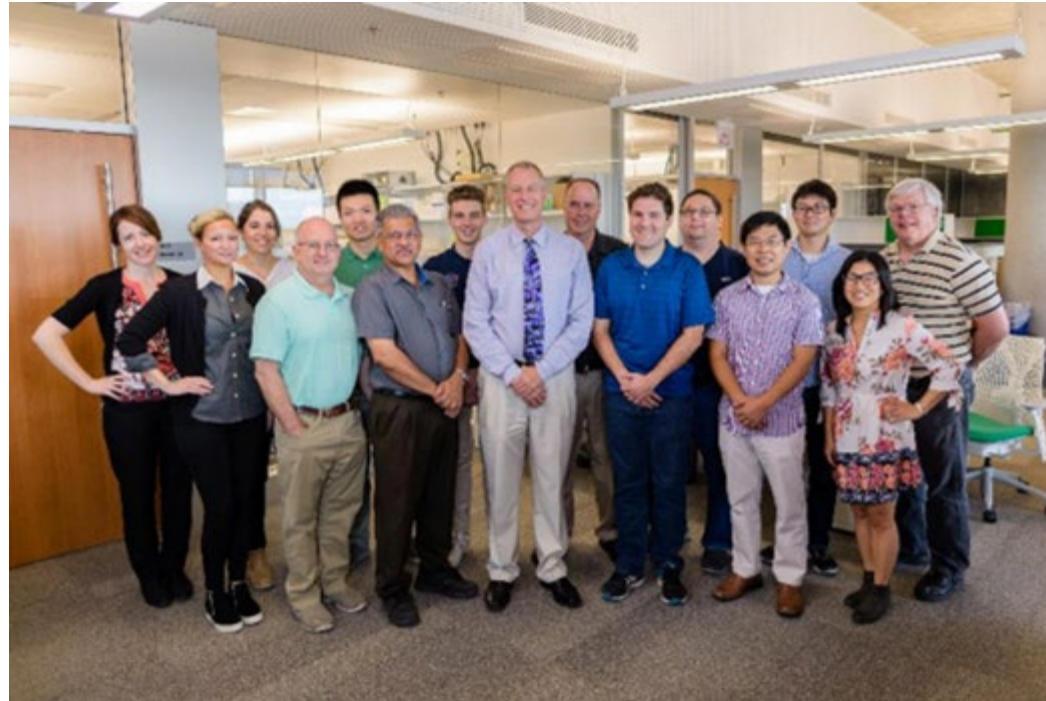
Dr. Frederic Zenhausern

Kellys Morara

Dr. Jianing Yang

Dr. Jerome Lacombe

And all ANBM Research Staff



Questions

Thank
You for
Your Kind
Attention

