Bloom Growth in Chocolate: The Application of Profilometry to Study Transformations and Aging

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collaborate > create > succeed

Application of Profilometry

- **Chocolate Bloom**
- **Other techniques**
  - Atomic Force Microscopy
  - Environmental Scanning Electron Microscopy
- **Profilometry**
- **Aging of Chocolate**
- **Conclusions**

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Chocolate Bloom

- **Loss of gloss and graying of chocolate surface**
- **Poor appearance – Any reason**
- **2 main causes**
  - Sugar bloom
    - Sugar recrystallisation, humidity problems
  - Fat bloom
    - Cocoa butter recrystallisation
    - Transformation from desired form V to stable form VI
    - Poor tempering
    - Poor storage
    - Filling fats

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Chocolate Bloom Studies

- **Difficult to study and Monitor Development**
- **Surface behaviour**
- **Nature of chocolate leads to difficulties for microscopy**
- **Slow time development**
- **Difficult to observe changes**

- **Development of Different techniques**

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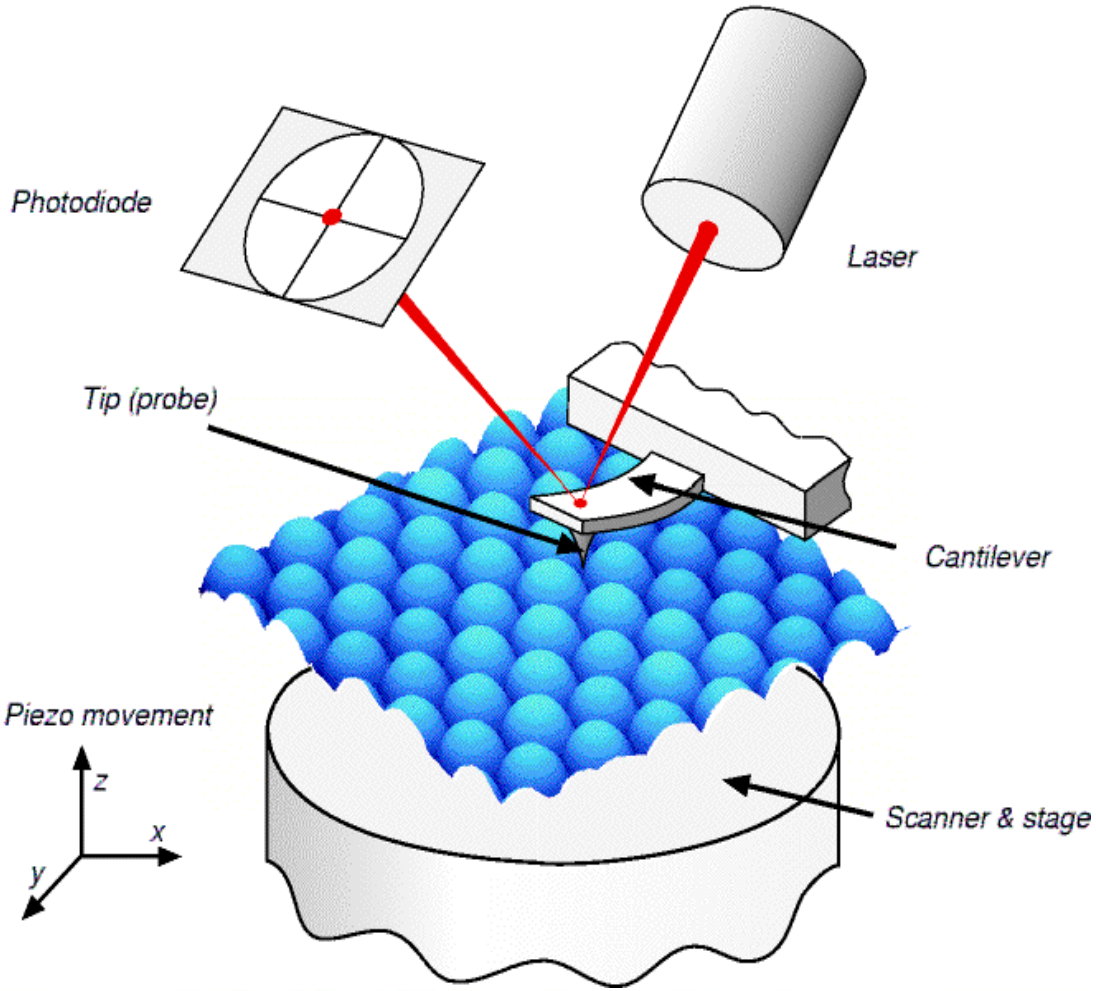
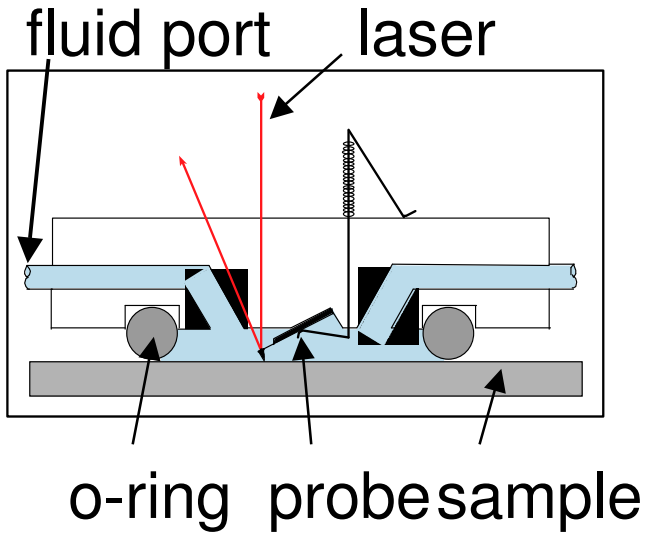
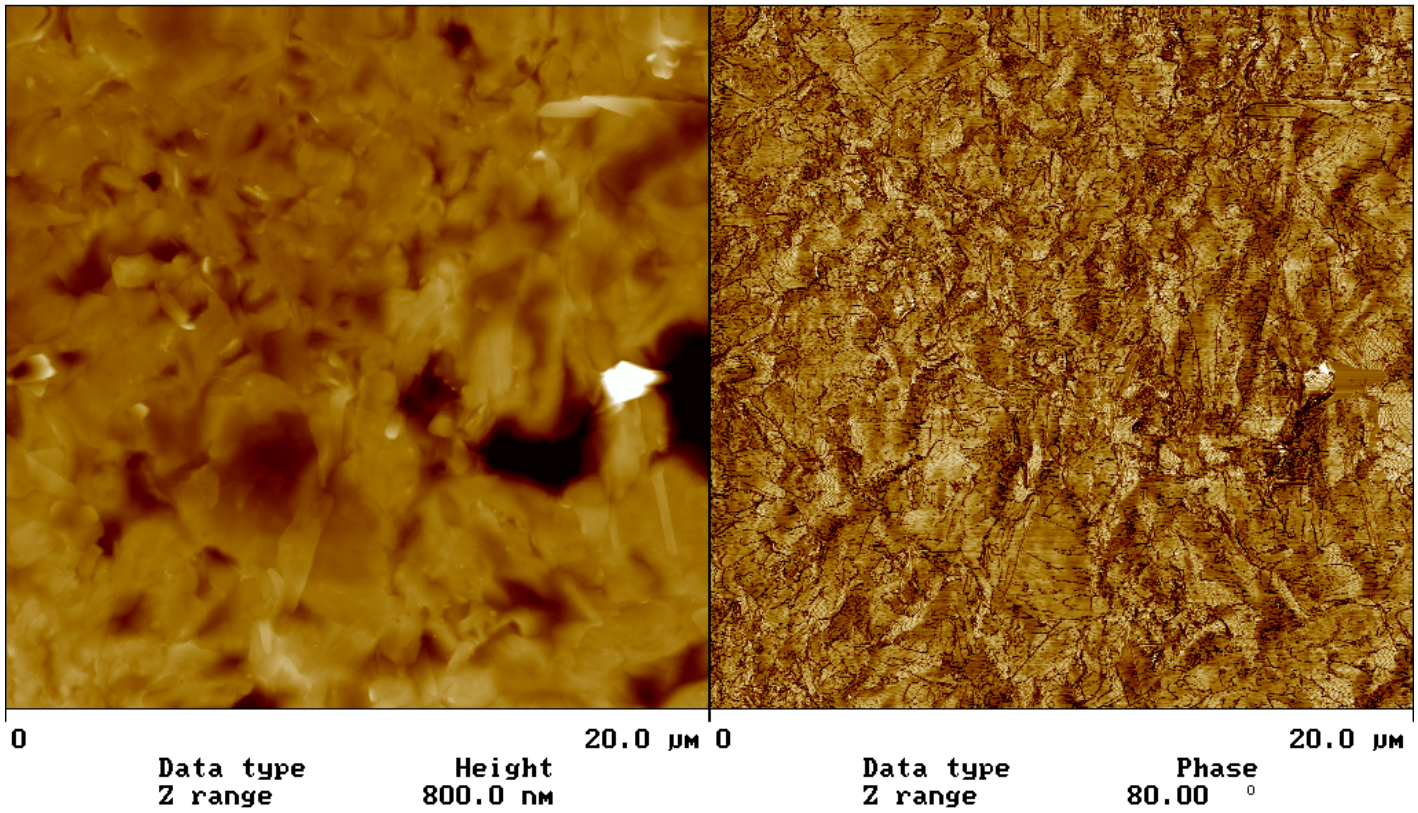
Principle of AFM





Fresh Dark Chocolate



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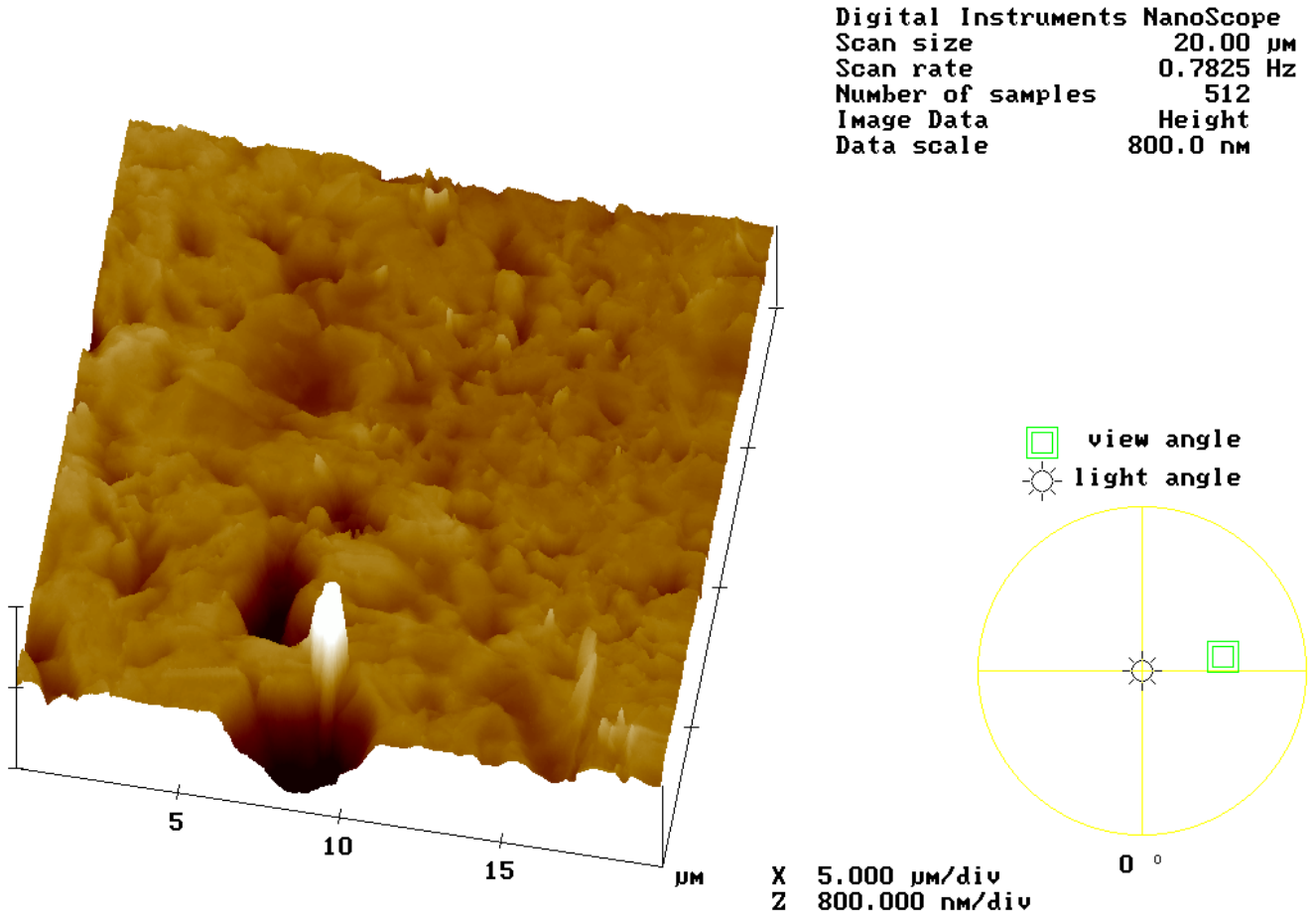
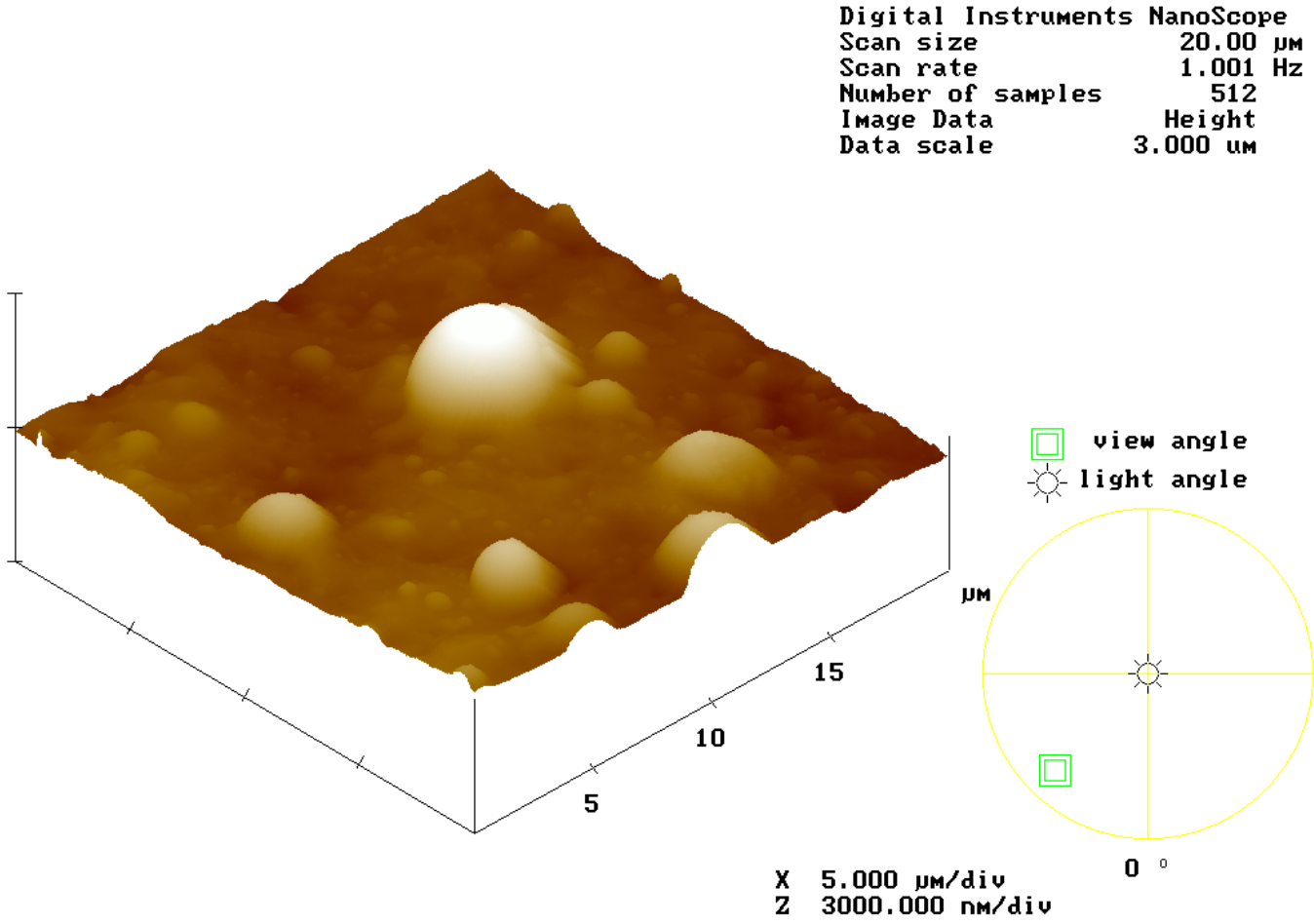
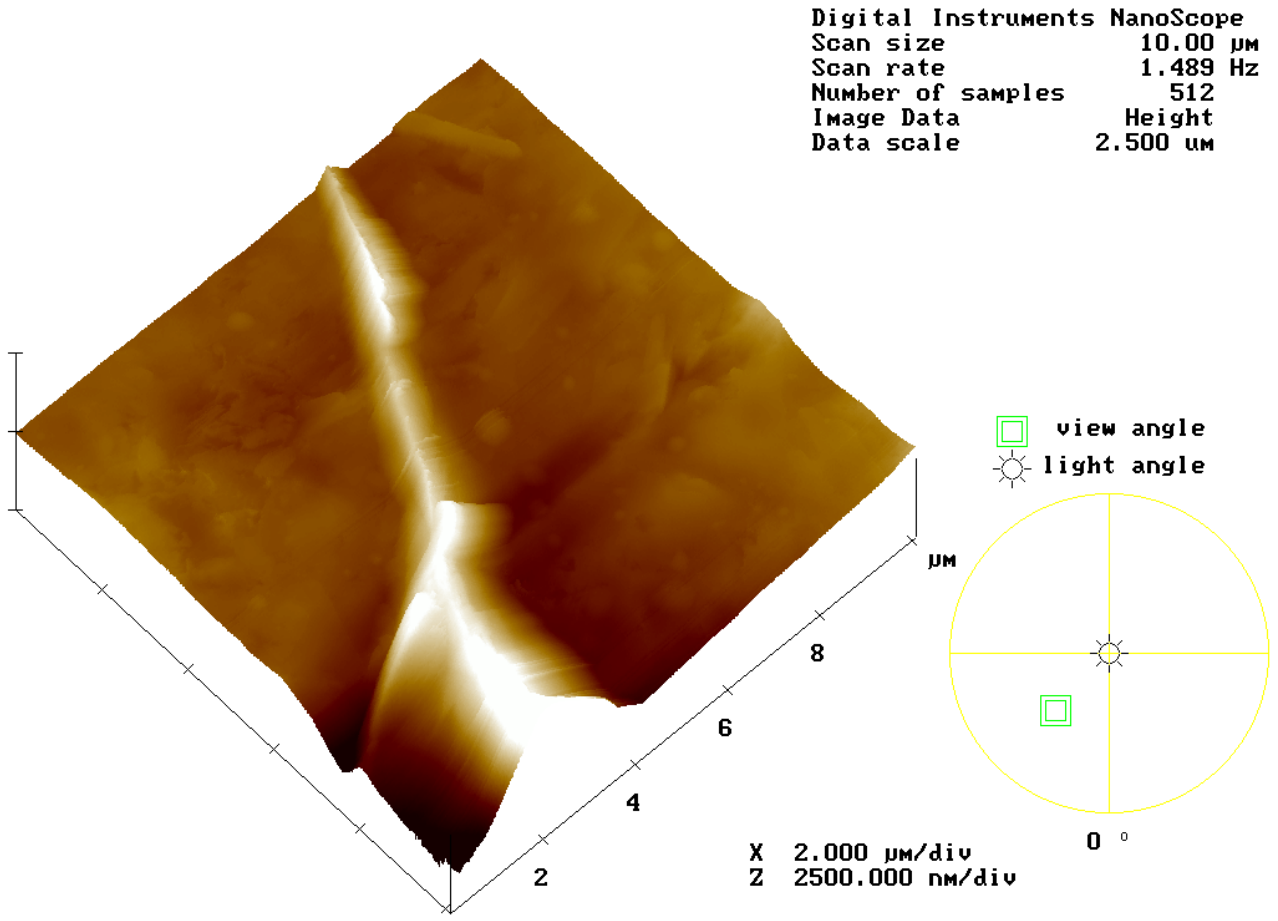
Fresh Dark Chocolate (3D view)



Dark Chocolate after 2 months



Dark Chocolate after 5 Months (Bloom Crystal)



Atomic Force Microscopy Conclusions

- **Resolution of very small structures**
- **Physical information about surface**
- **No special treatment**

- **Contact technique**
- **Destructive**
- **Time consuming**

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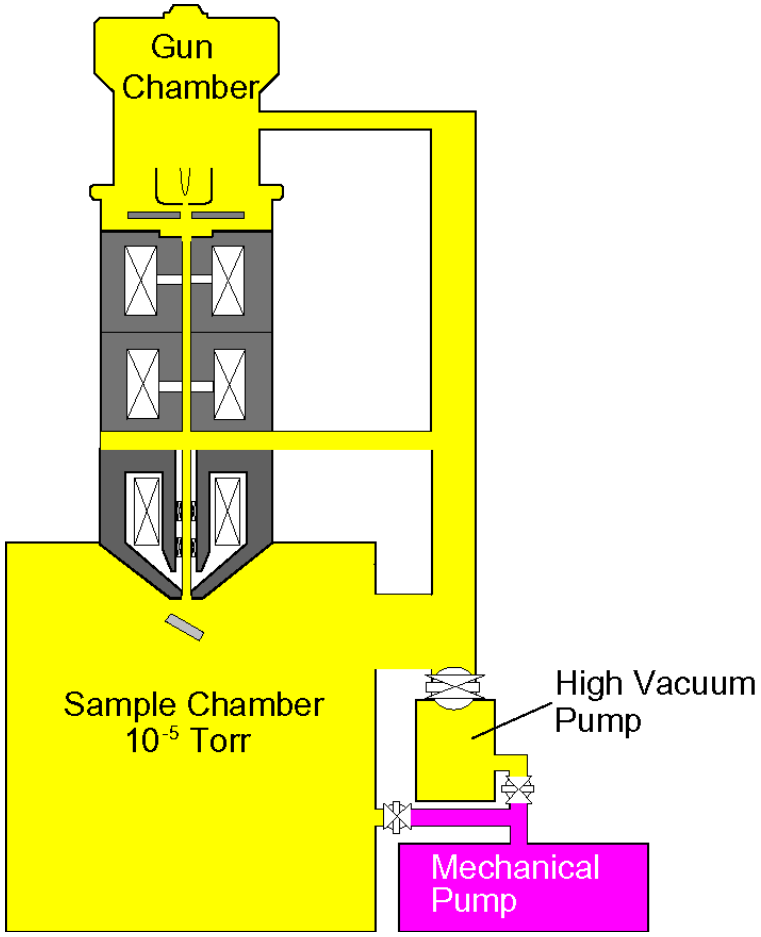
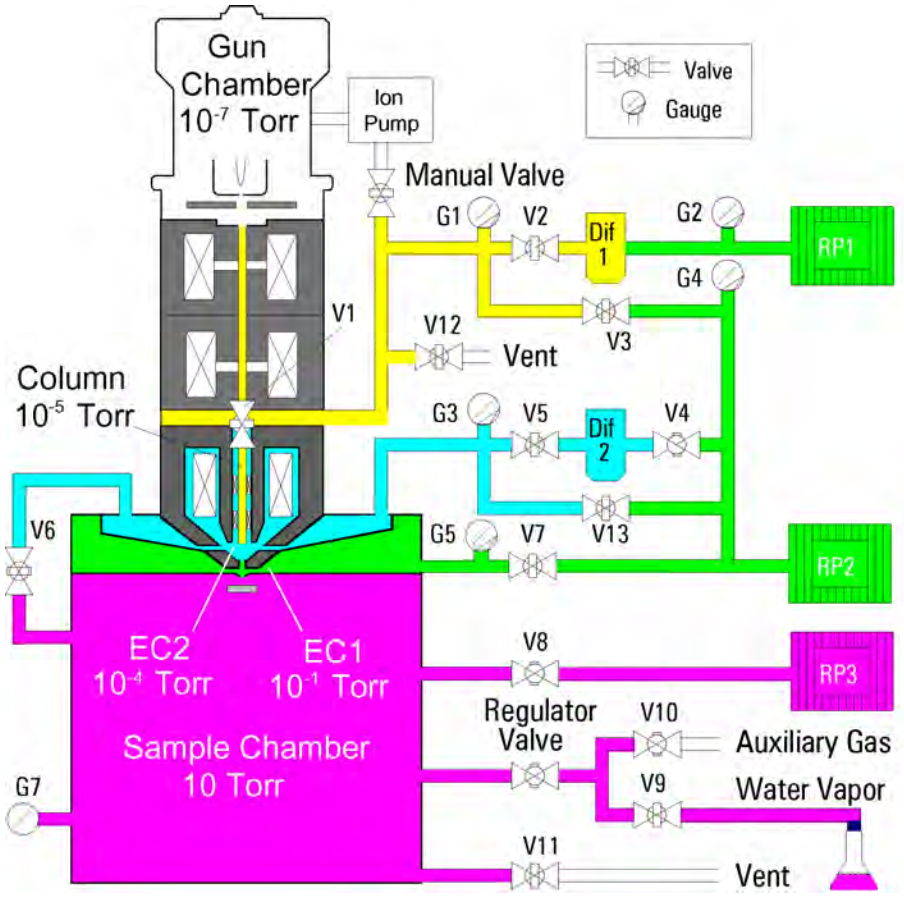
SEM v ESEM



SEM



ESEM

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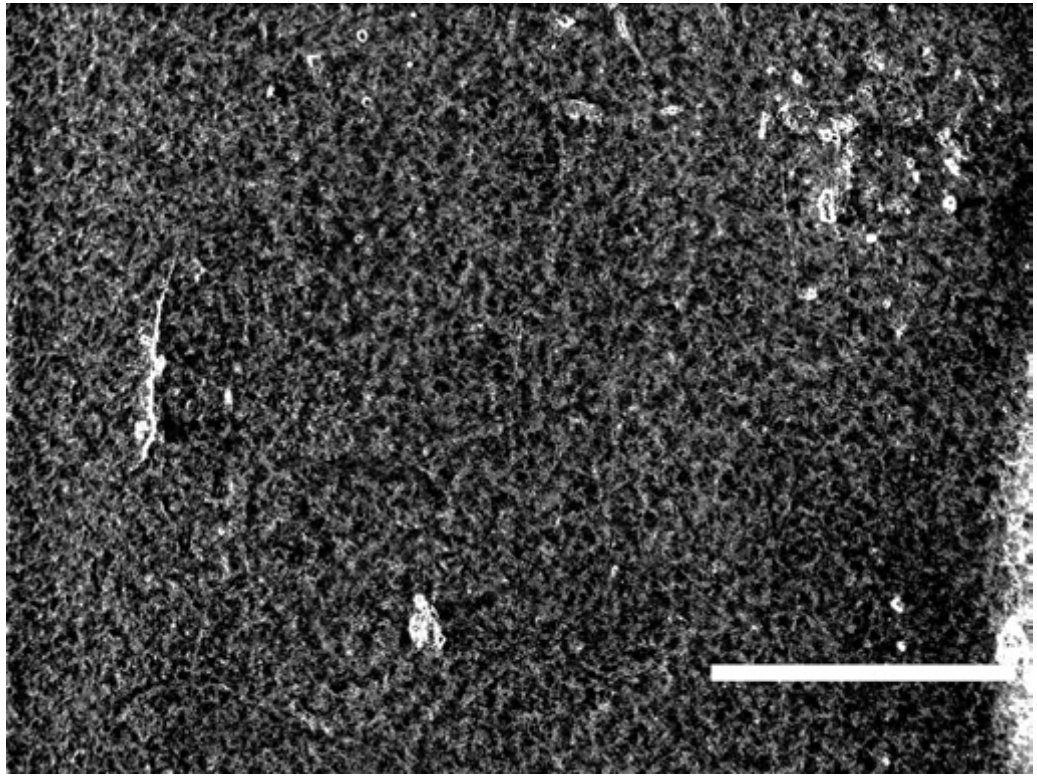
Dark Chocolate Surface



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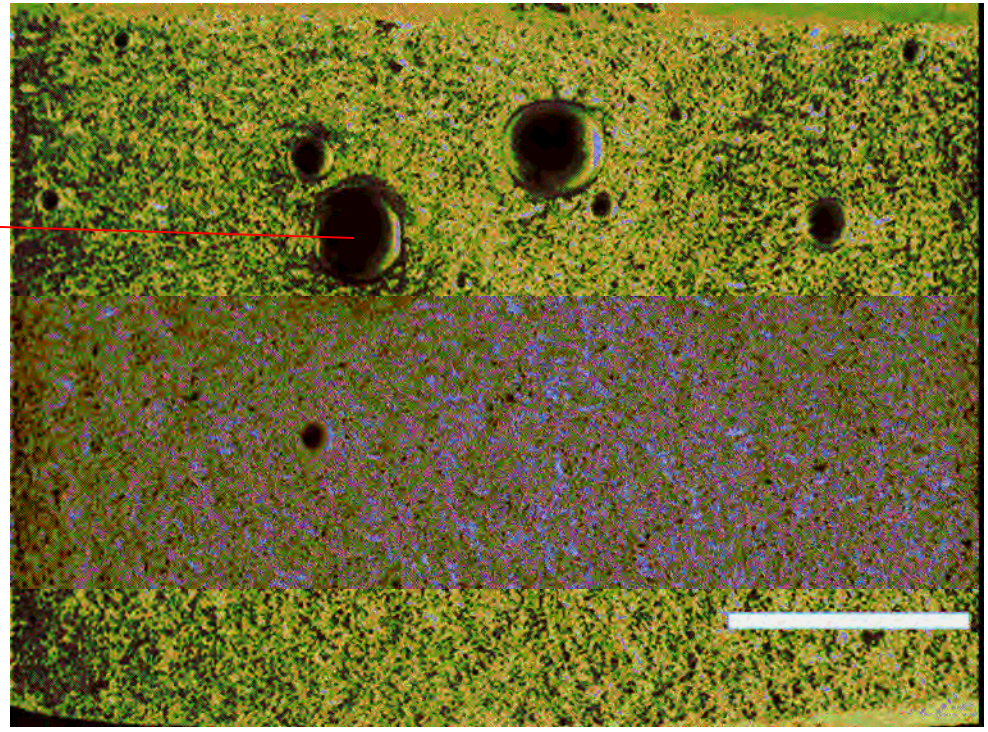
Cross Section of Chocolate

Bubbles



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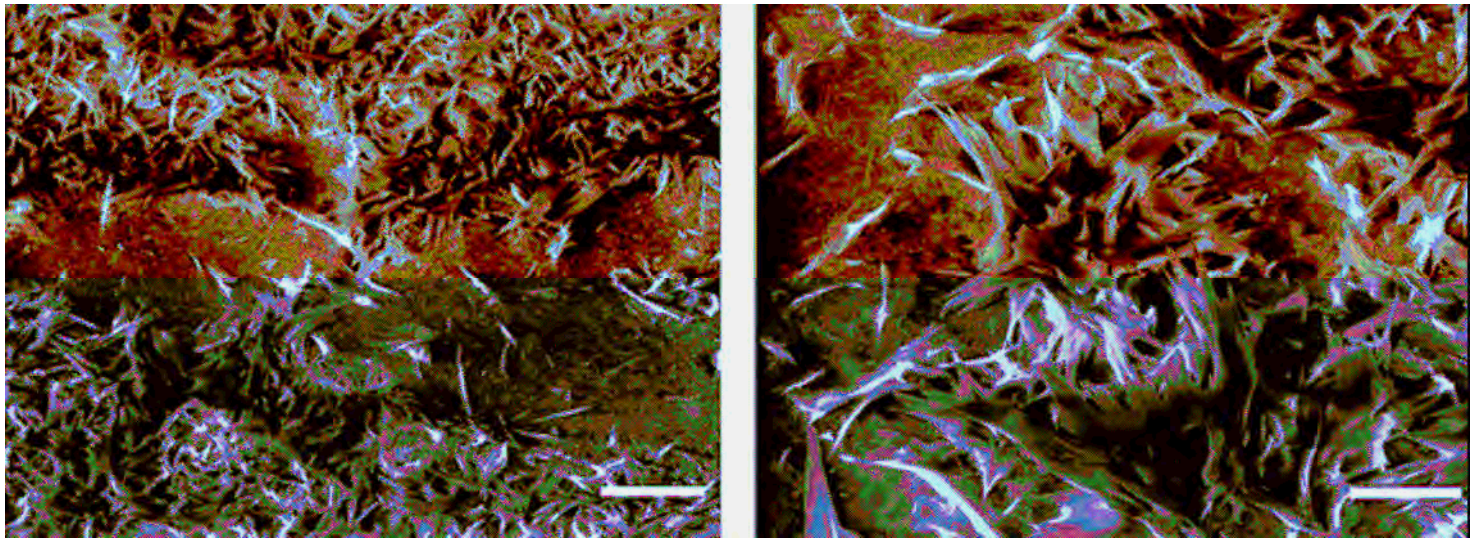
Bloomed Chocolate



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Environmental Scanning Electron Microscopy Conclusions

- **Very good resolution possible**
- **Surfaces do not need to be as well defined as for AFM**
- **Cross sections can be measured**
- **Whole samples can be studied and repeat measurement is possible.**

- **Samples need to be placed in an environmental chamber**
- **Risk of damage by electrons**

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Profilometer

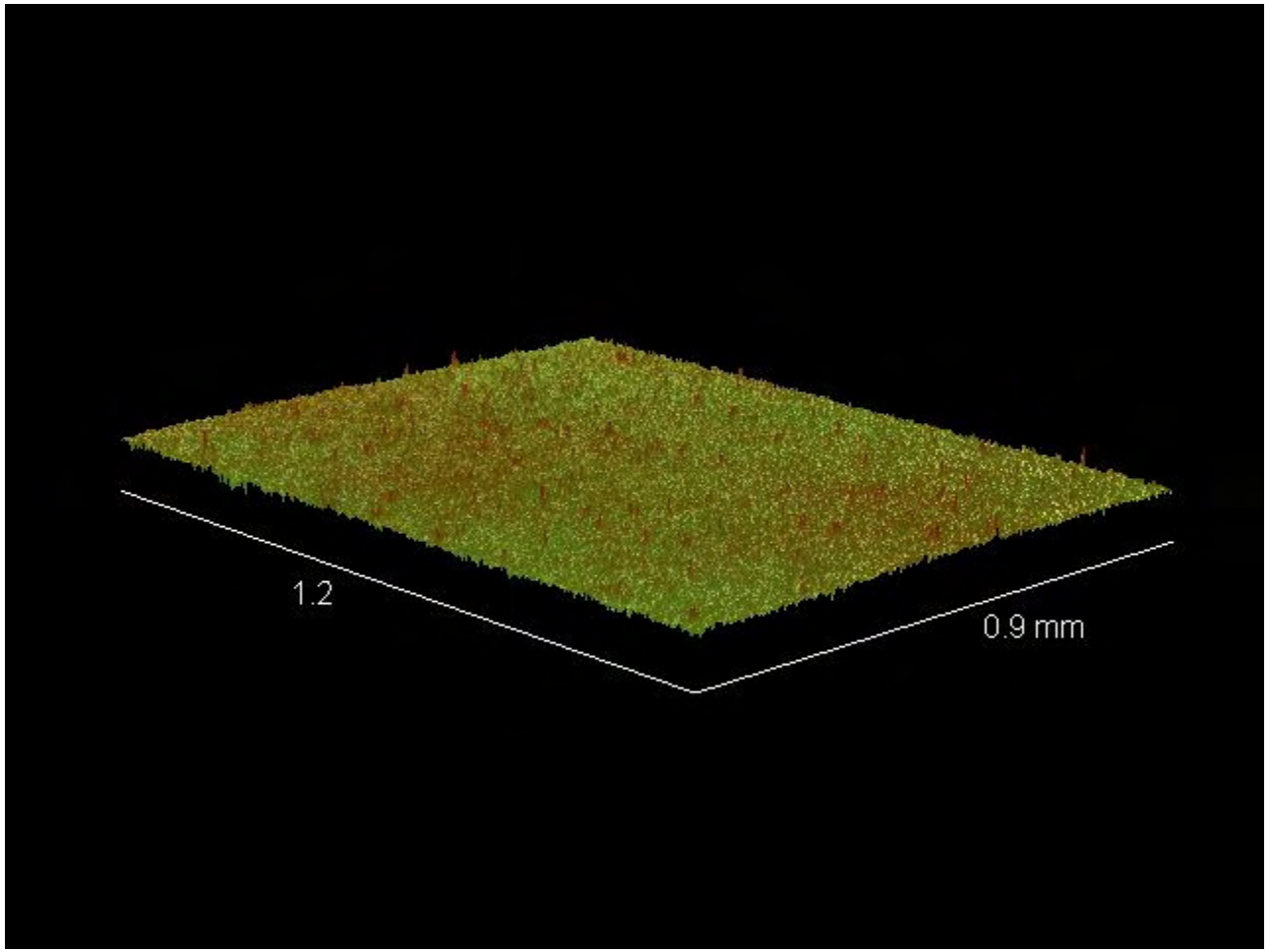
Profilometer: Principles

- **Interference patterns are measured at different heights through the range of the surface.**
- **From these the computer calculates a 3D surface map.**
- **Stitching of images can give views of very large surface areas.**

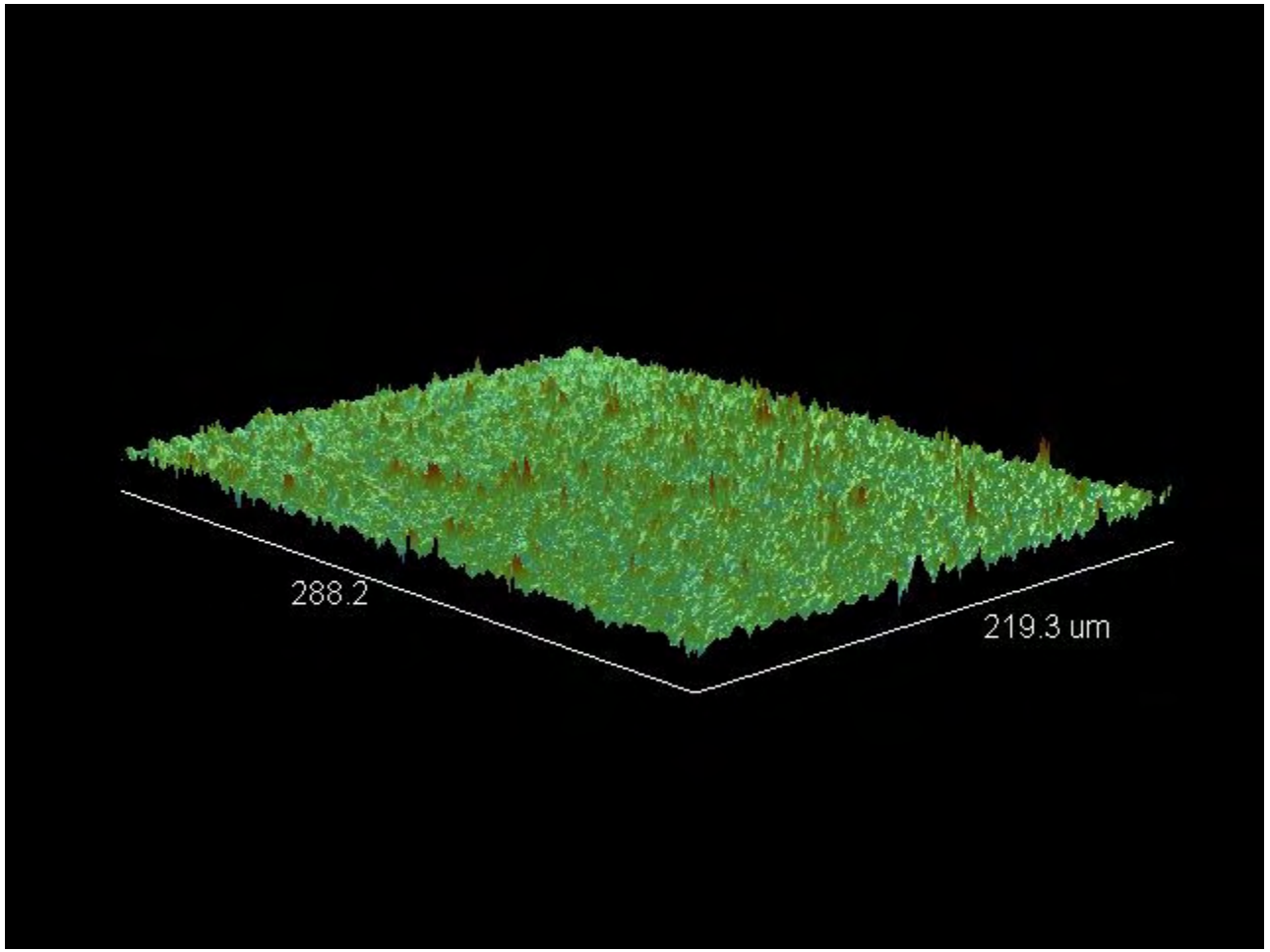
Melting of Chocolate

- **Heat at 1ºC per minute from 20ºC**
- **Live measurement**

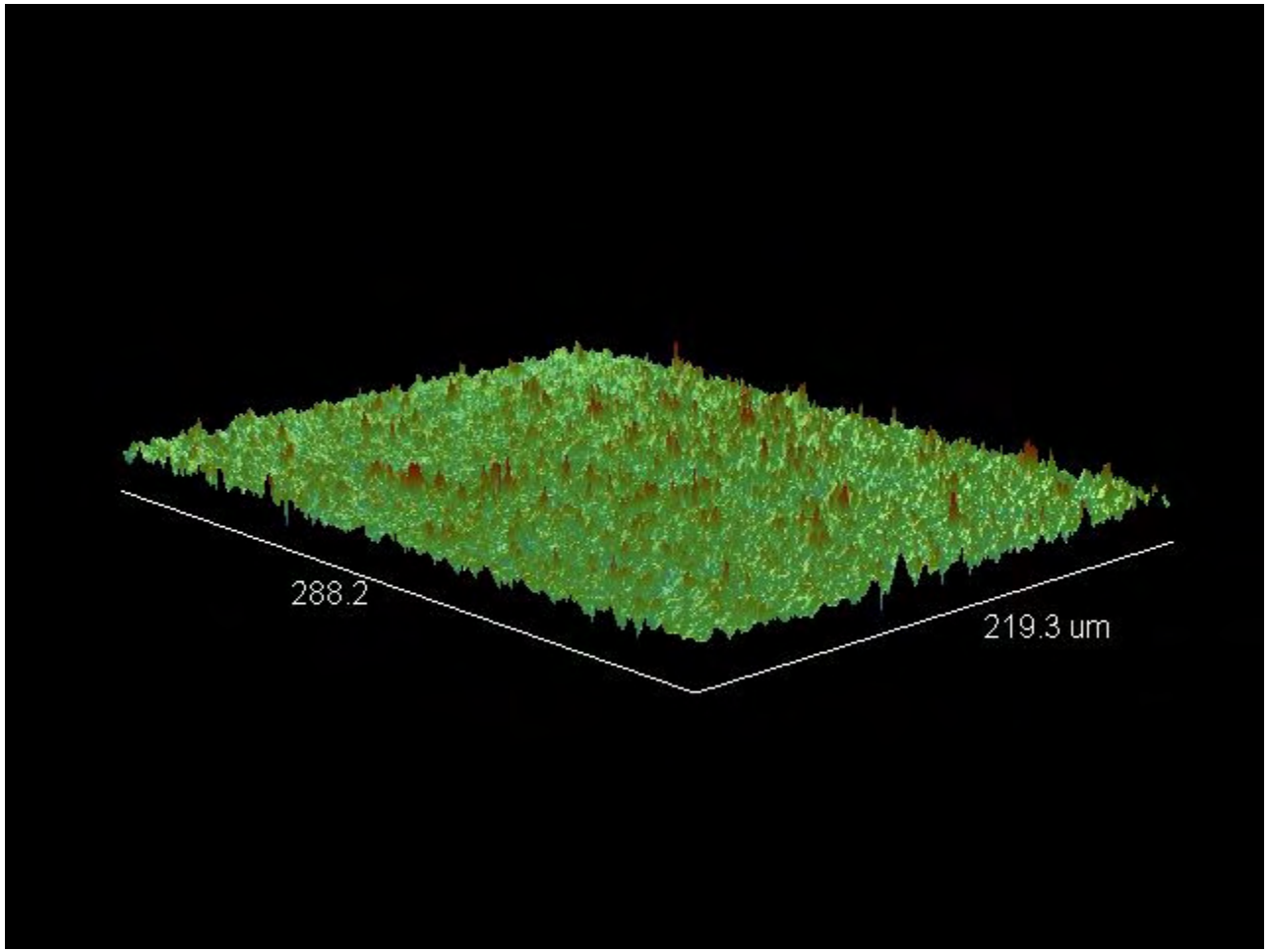
Milk chocolate 0 minutes 20ºC



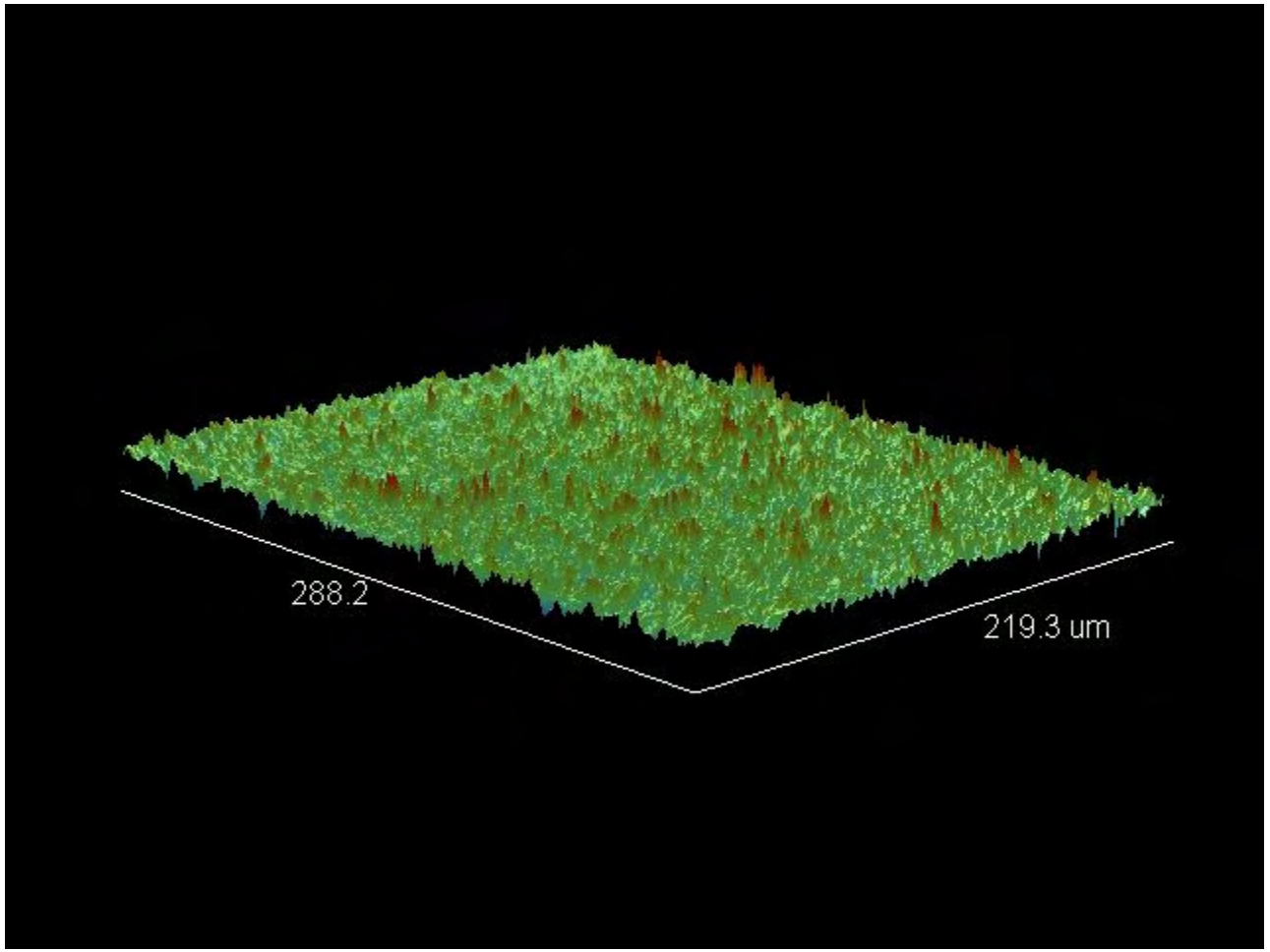
Milk chocolate 5 minutes 25ºC



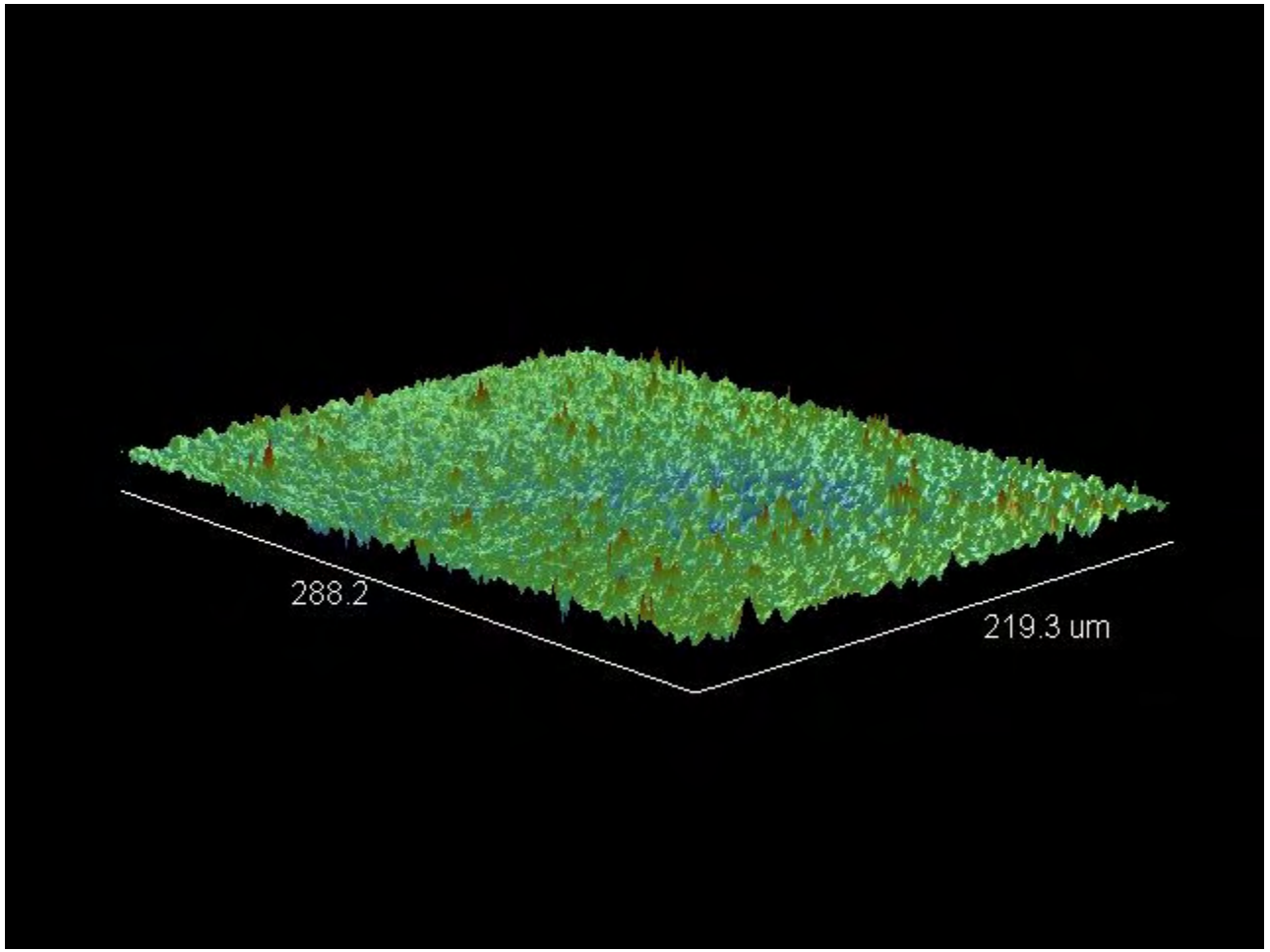
Milk chocolate 7minutes 27ºC



Milk chocolate 10 minutes 30ºC



Milk Chocolate 13 minutes 33ºC



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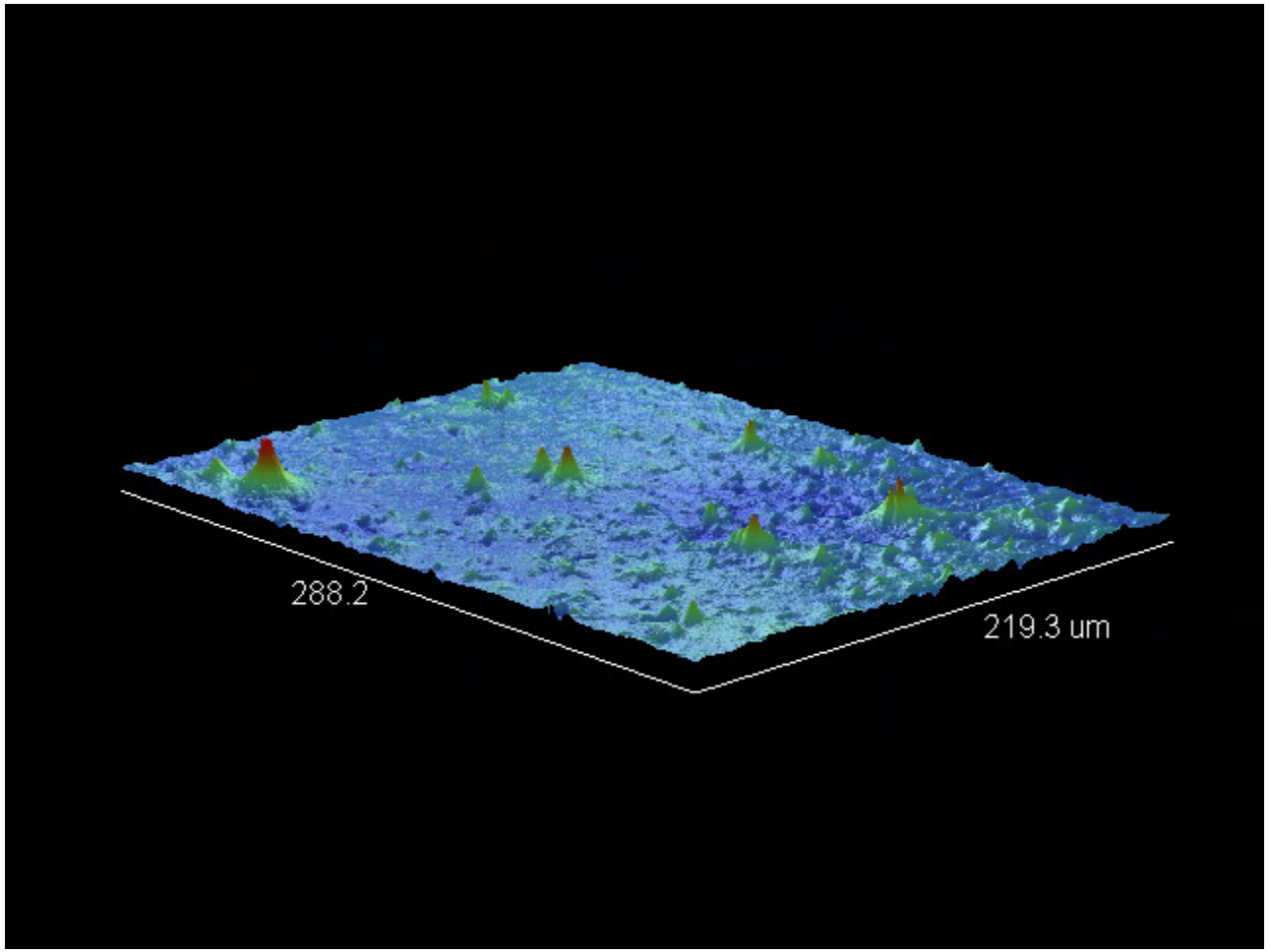
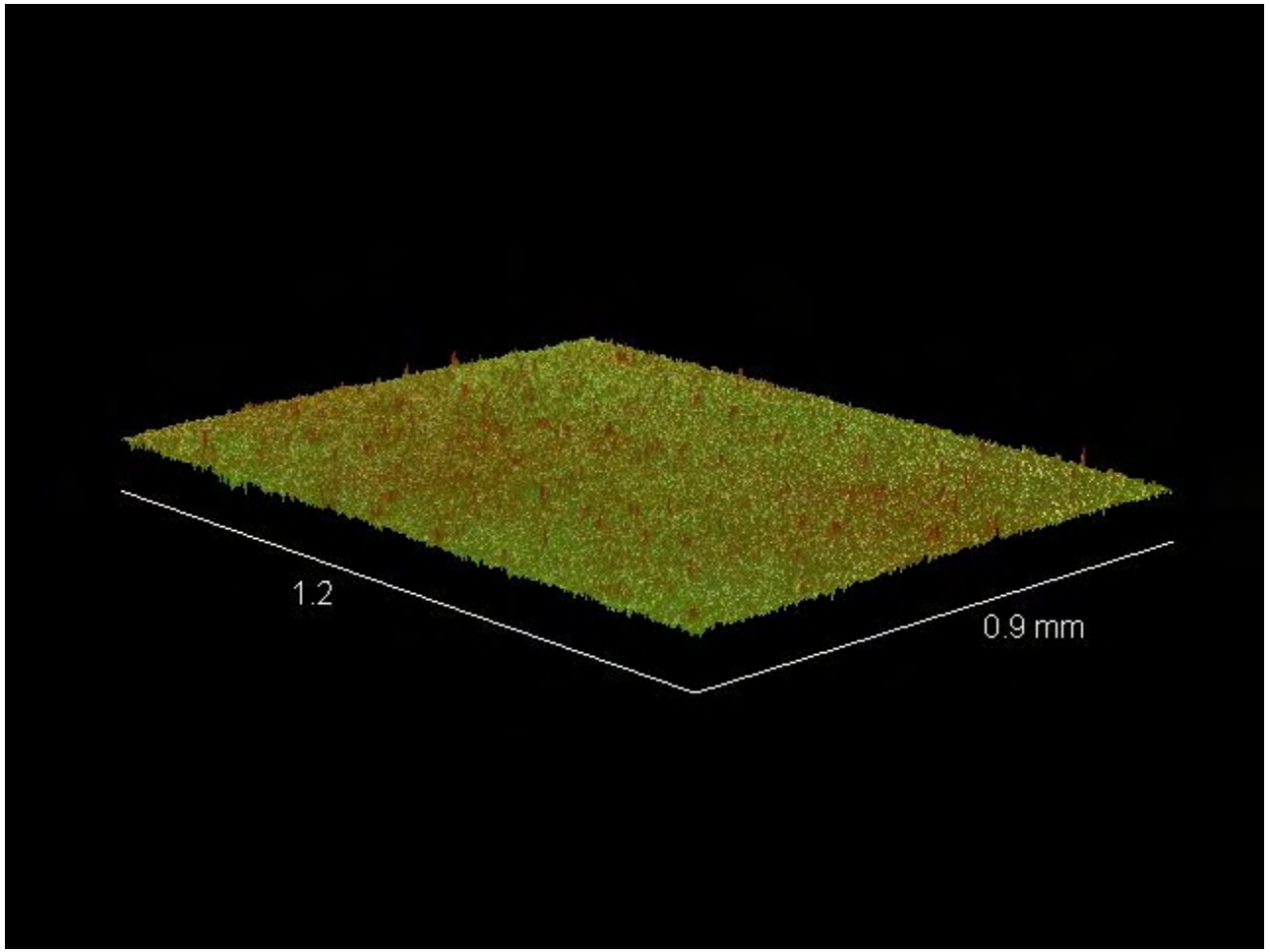
Milk Chocolate 15 minutes 35ºC



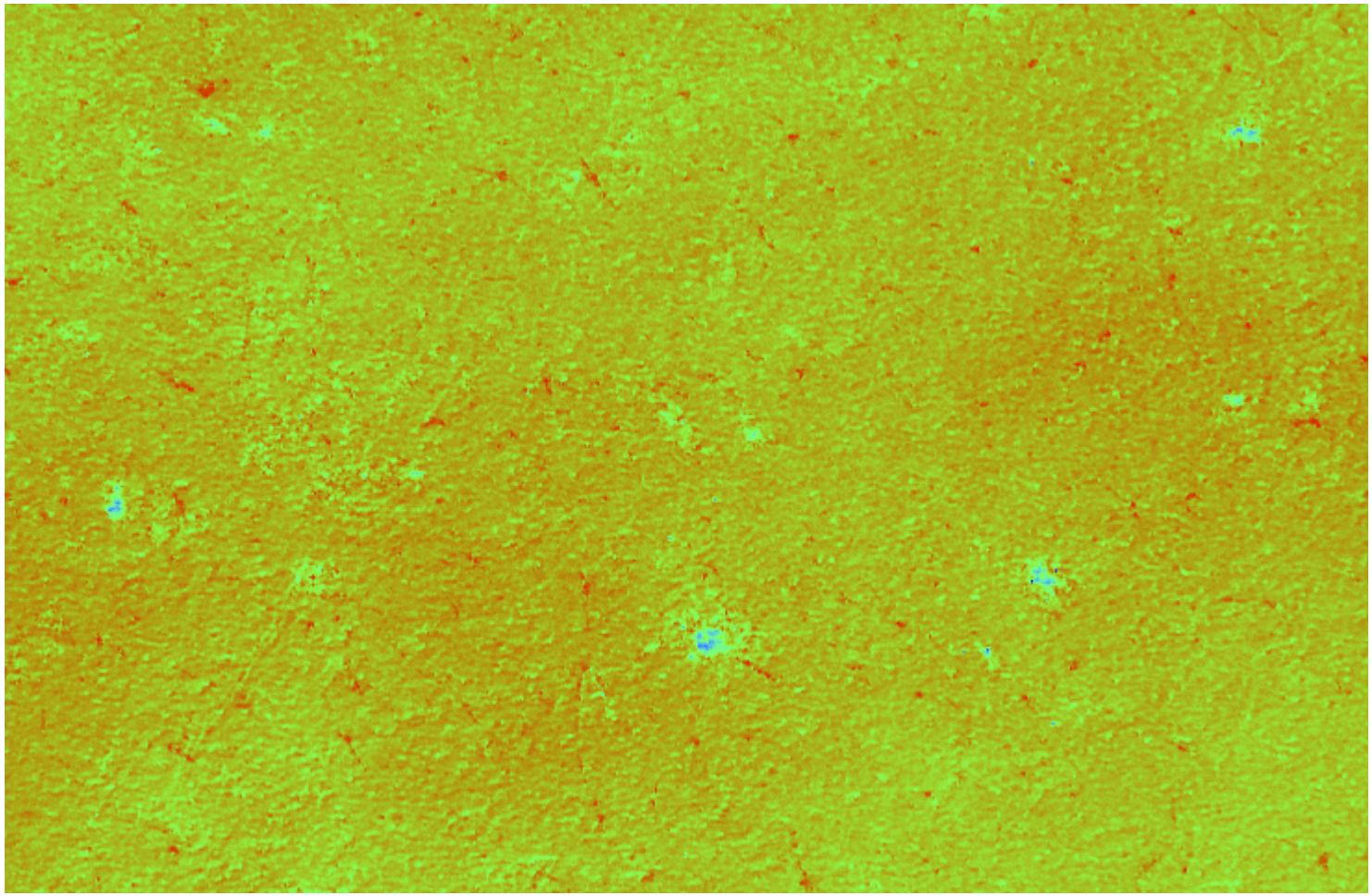
Chocolate Storage

- **Stored over 2 weeks**
- **Isothermal at 20ºC**
- **Temperature cycling 6 hours at 30ºC & 6 hours at 20ºC**

Milk chocolate 0 days



Milk Chocolate 0 days



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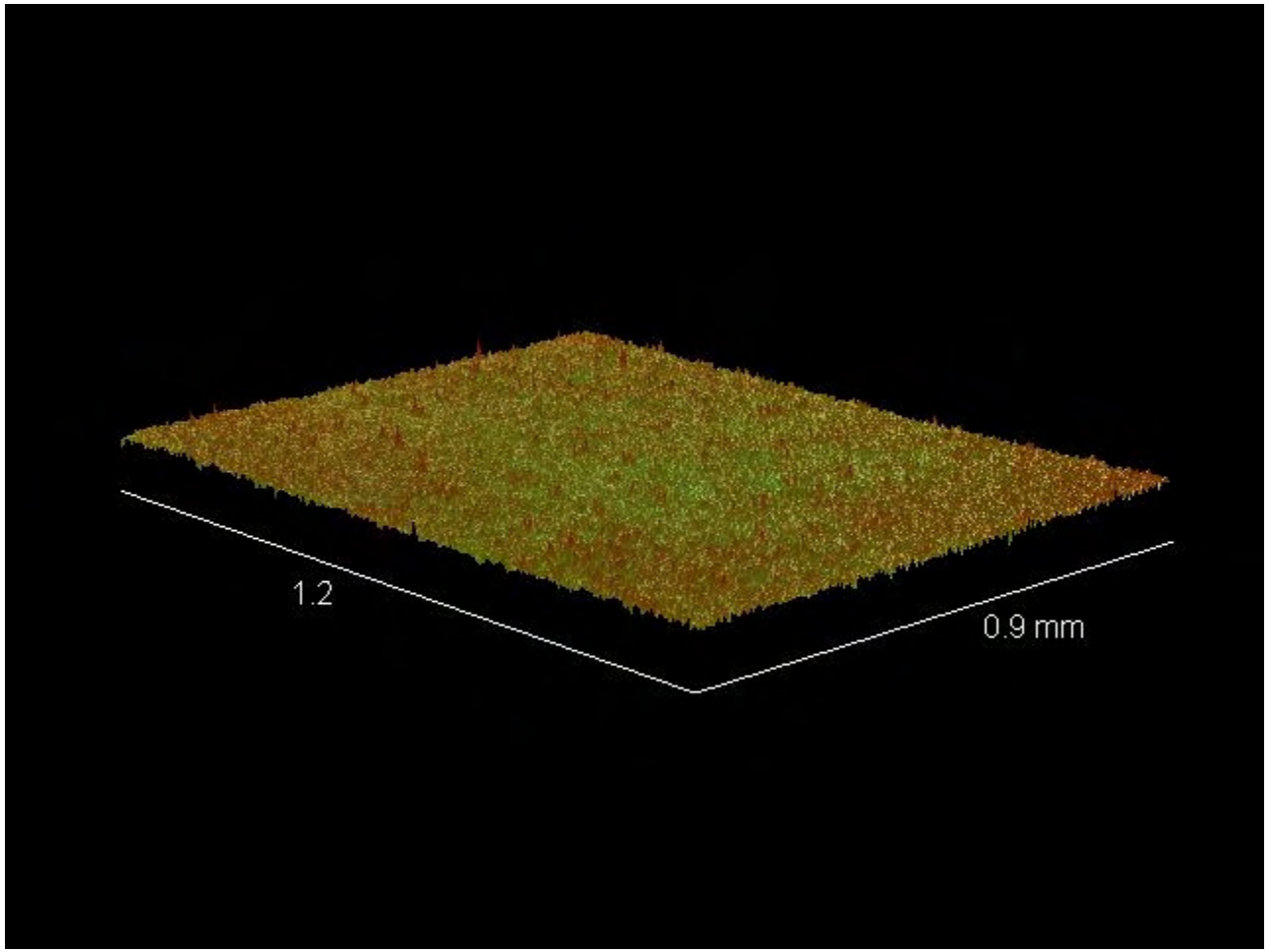
Isothermal Chocolate 13 days



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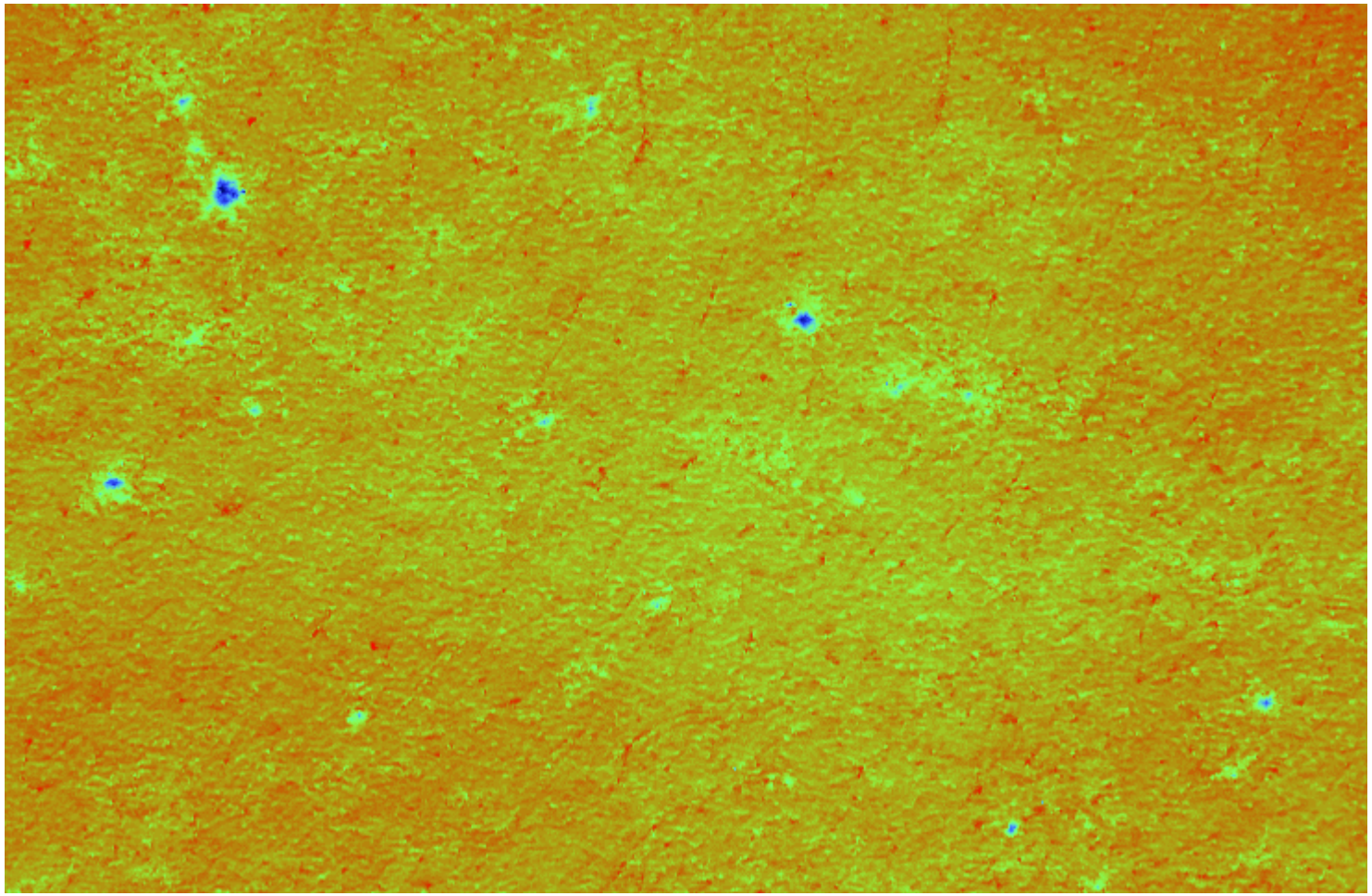
Isothermal Chocolate 13 days



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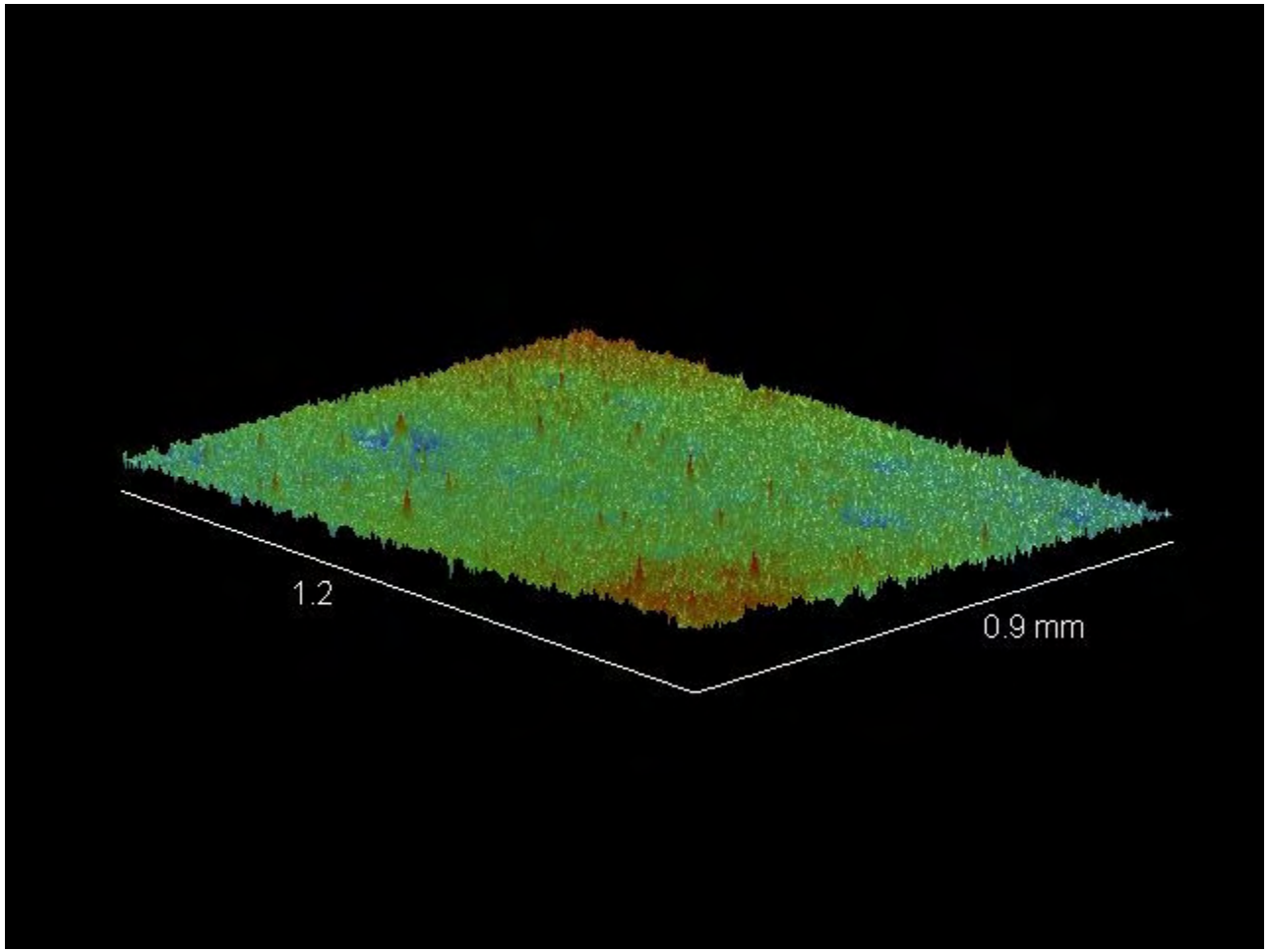
Cycled Chocolate 13 days



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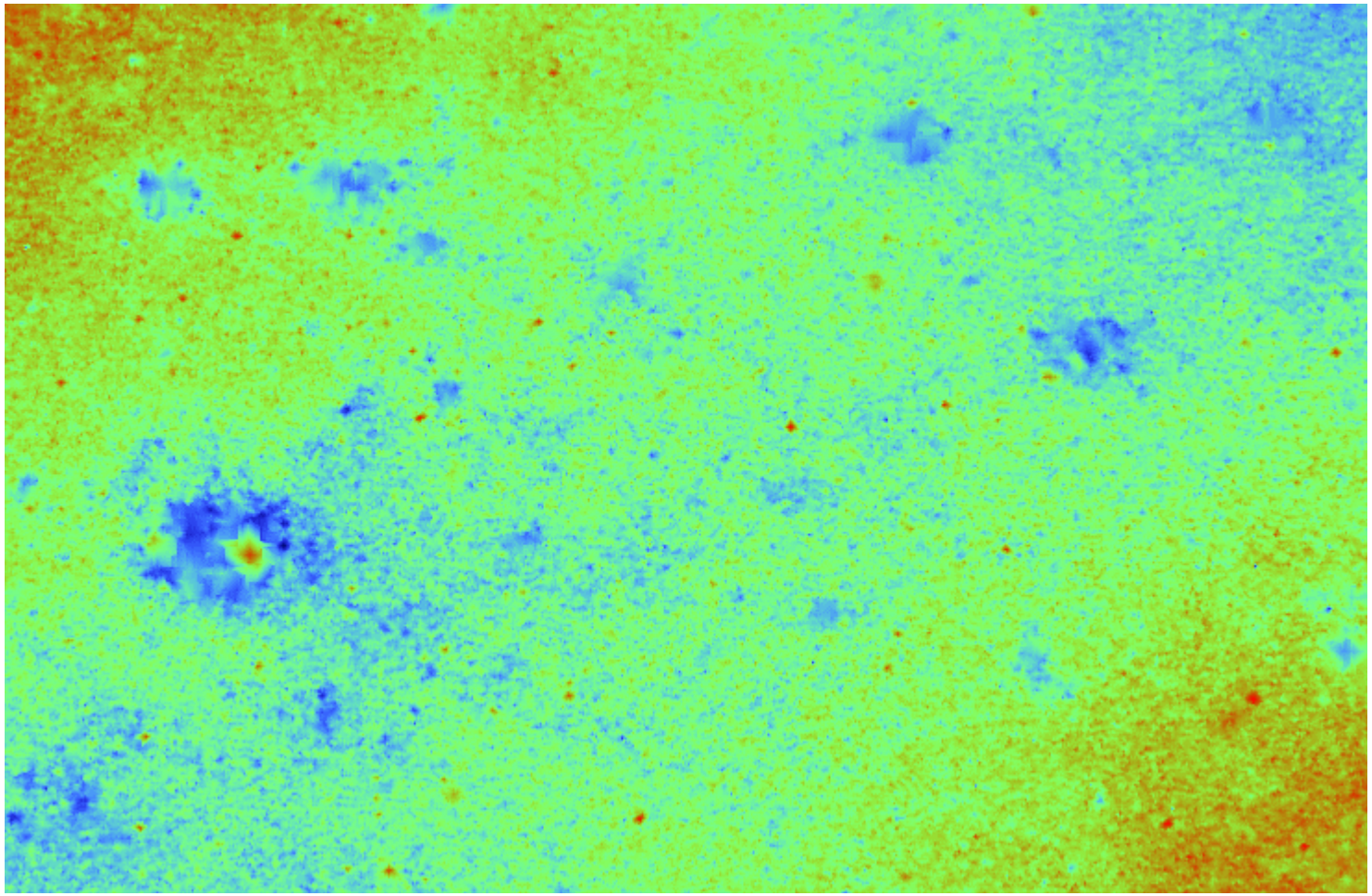
Cycled Chocolate 13 days



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Roughness Changes of the Samples

Sample	Rq	Z range (nm)
Day 0	119.80	3.43
Day 13 Isothermal	152.62	3.83
Day 13 Cycled	482.53	5.41

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Profilometry Conclusions

- Good surface representation is possible
- No strange treatments are needed
- The same spot can be studied time after time
- Quick and easy technique

- High quality surfaces are needed for good resolution

Conclusions

- **All 3 techniques are useful to understand the structure of chocolate and the nature of chocolate bloom**
- **In particular profilometry is useful for studying surface changes and monitoring transformations in real time**

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Acknowledgements

- **Annika Dahlman & YKI Institute for Surface Chemistry, Stockholm, Sweden.**