

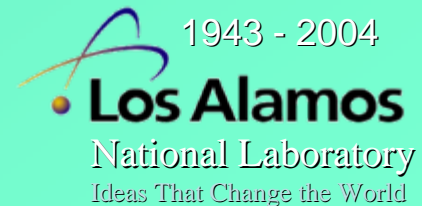
# *AFM Studies of Er Film Structures and Evolution*

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Los Alamos National Laboratory

Co-Investigators  
G.W. Brown and T.N. Taylor

Hydrogen Isotopes & Helium in Materials

April 14, 2005  
Albuquerque, NM



# *Outline*

## *Structures*

Mo Substrate vs erbium film

## *Structures*

Different crystal structures

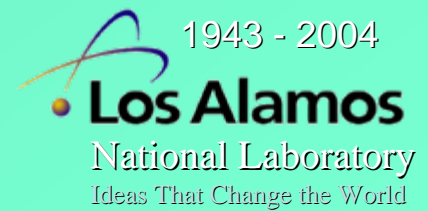
## *Structures*

Evolution as a function to exposure to air

## *Ideas for the future*



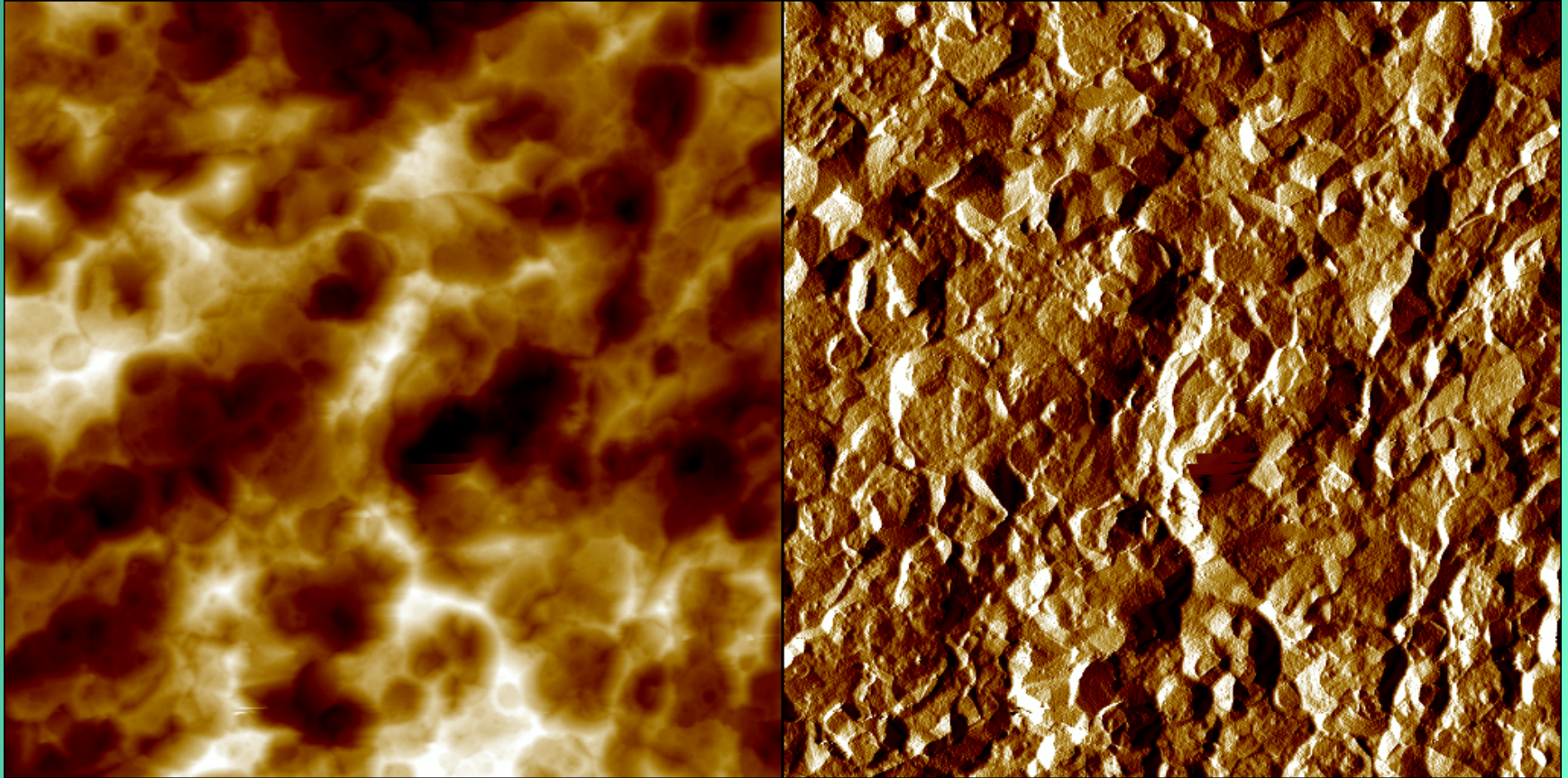
# *“Memory”* Lane



# *Relationship of the Erbium Film to Mo substrate*

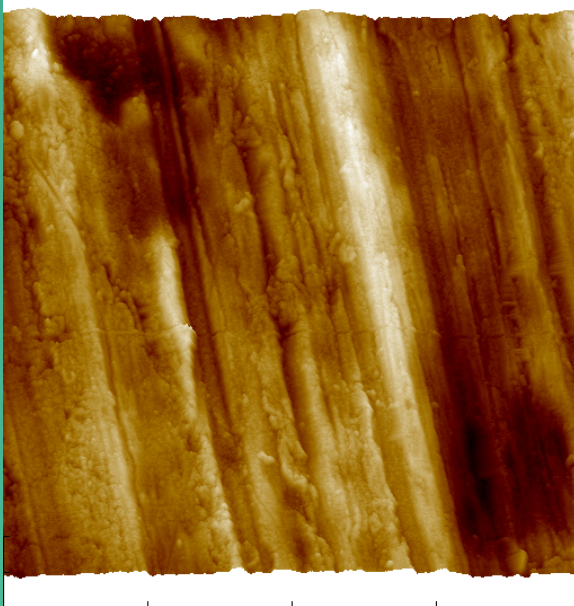
Topograph

Phase

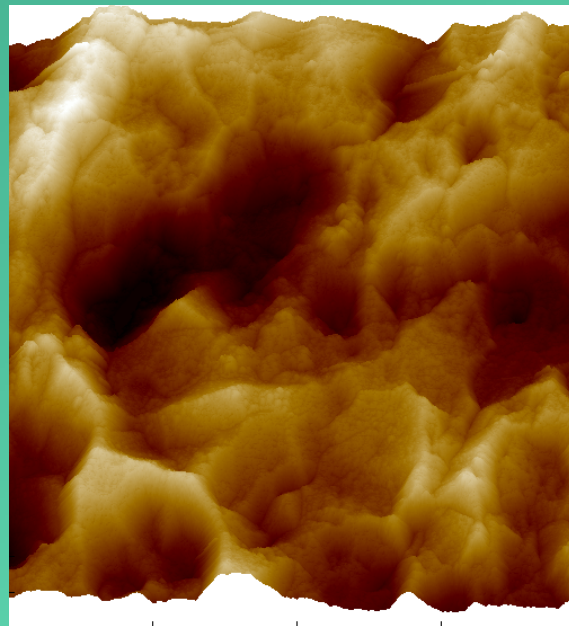


Bare Moly Substrate - 40  $\mu\text{m}$  scan size

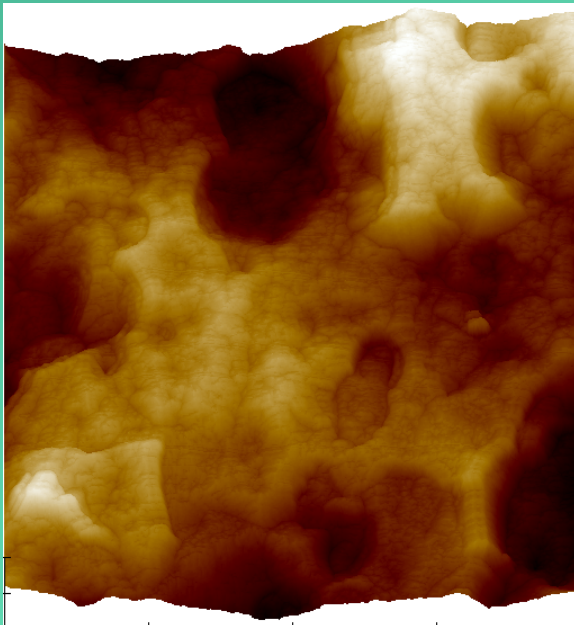




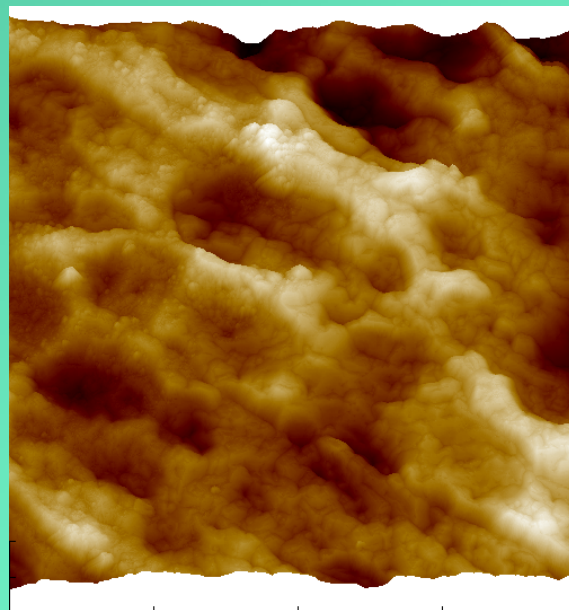
RMS = 80.8 nm



RMS = 309.5 nm



RMS = 279.4 nm



RMS = 153.0 nm

## Moly Substrates

Left - as received

Right - before deposition

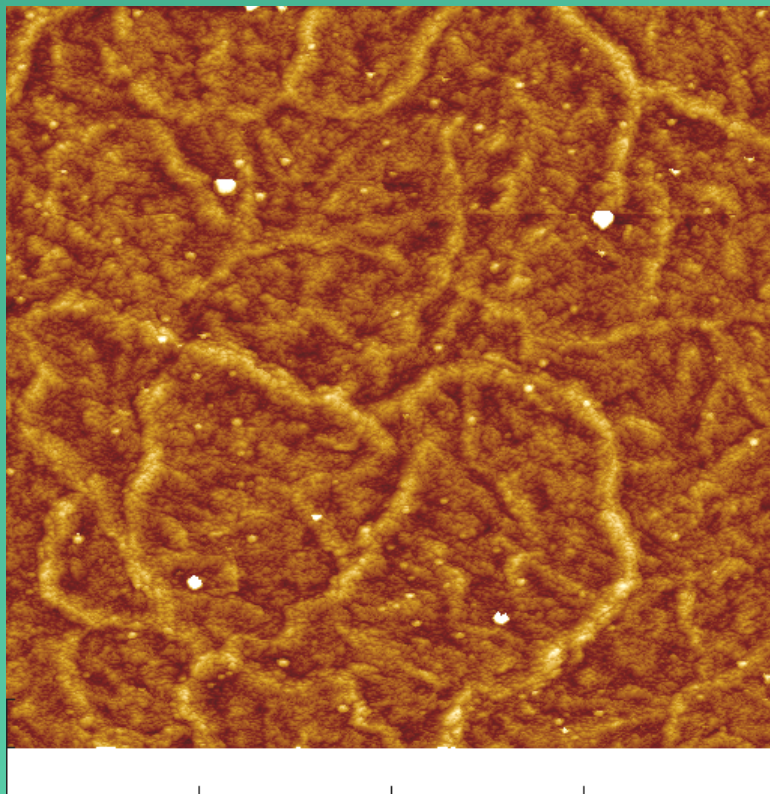
20  $\mu\text{m}$  scans

Vertical scale 1200 nm

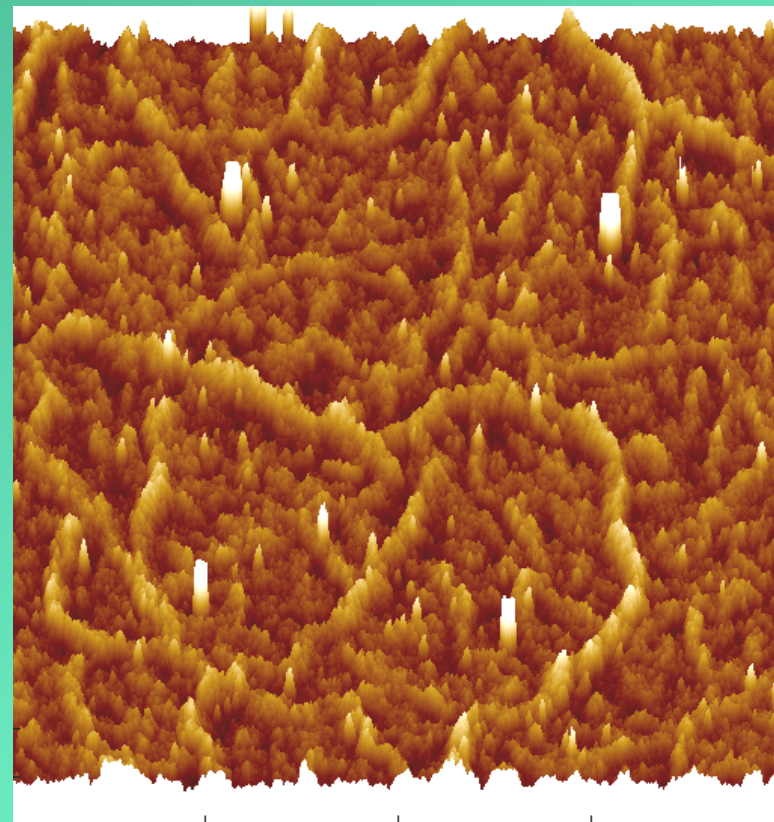
Erbium Films on Moly



# *Erbium Film on Single Crystal Silicon Substrate*



Vertical scale 1200 nm



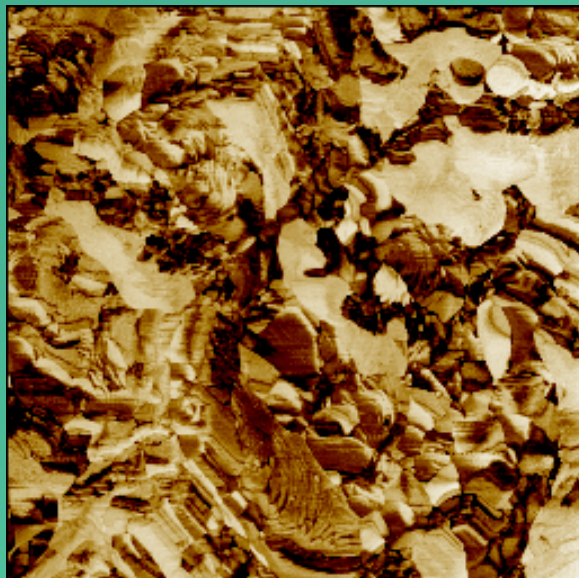
Vertical scale 60 nm

RMS = 6.1 nm

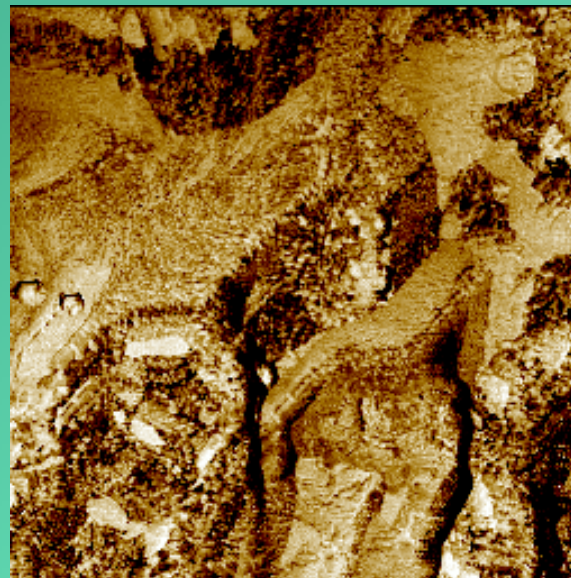
20  $\mu\text{m}$  scans



*5.0  $\mu\text{m}$  scans*

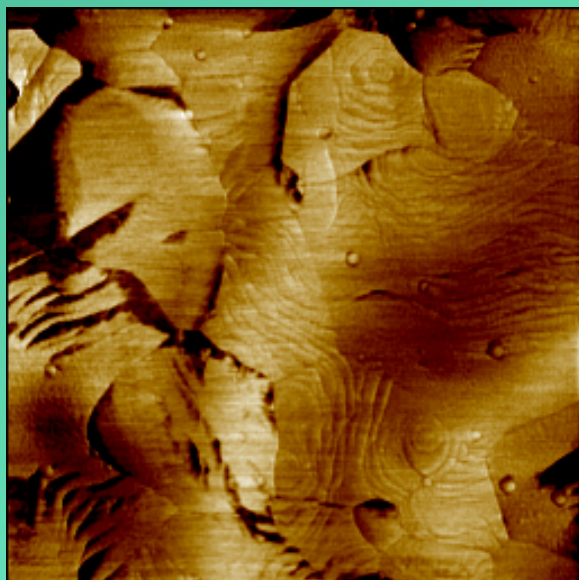


1036-014 unloaded

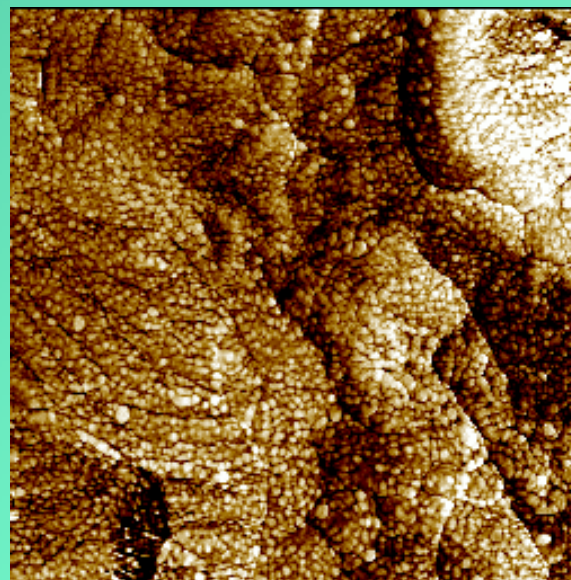


1036-018 loaded

*2.5  $\mu\text{m}$  scans*



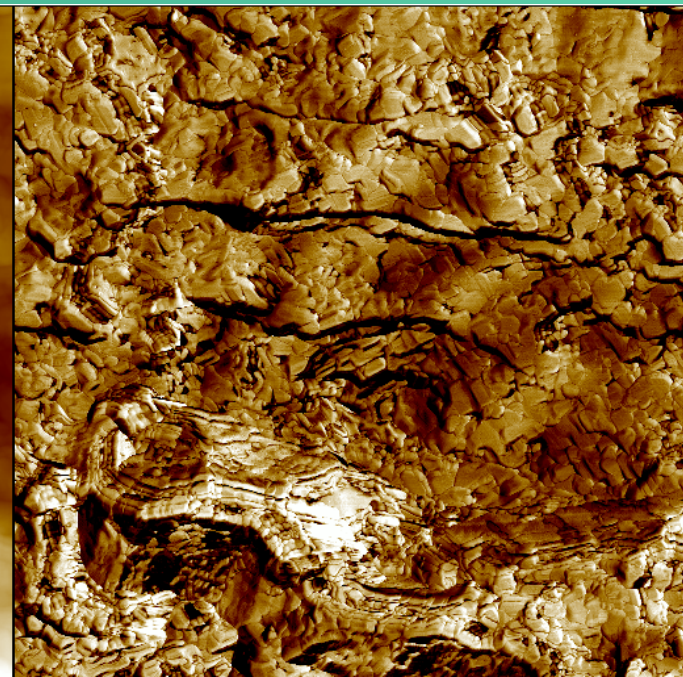
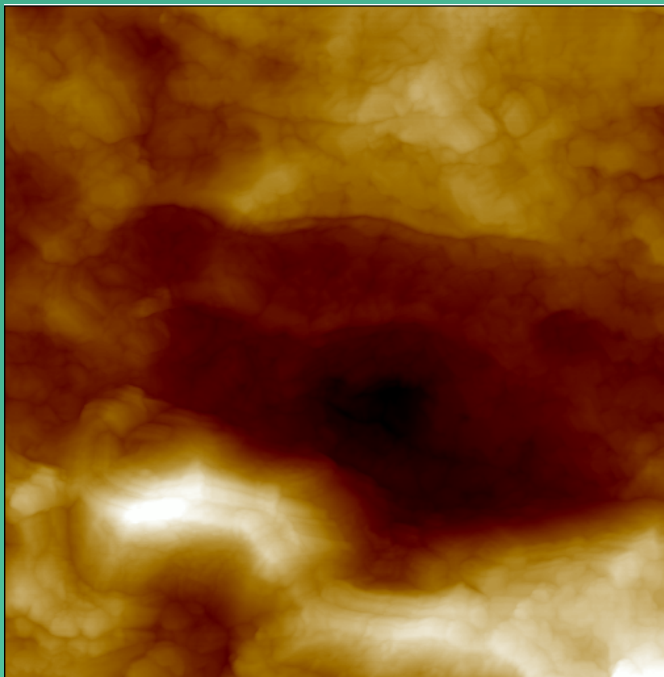
1036-005 unloaded



1036-015 loaded

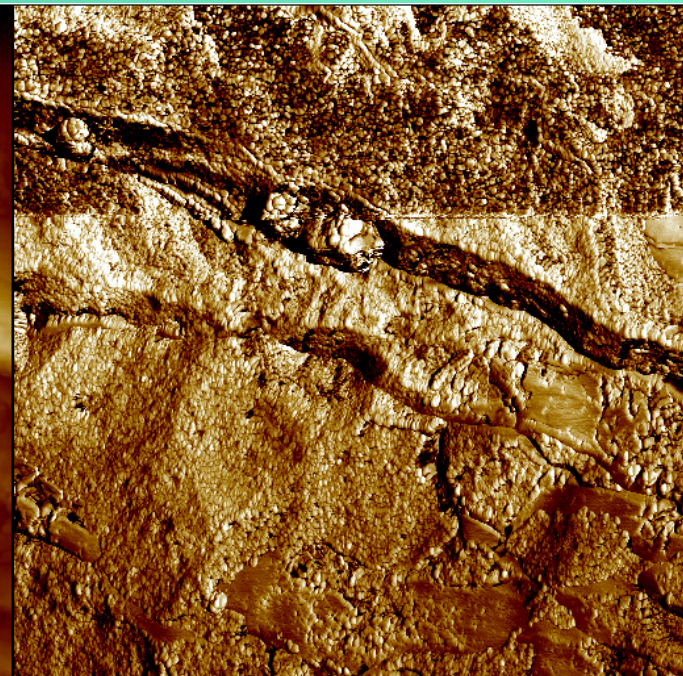
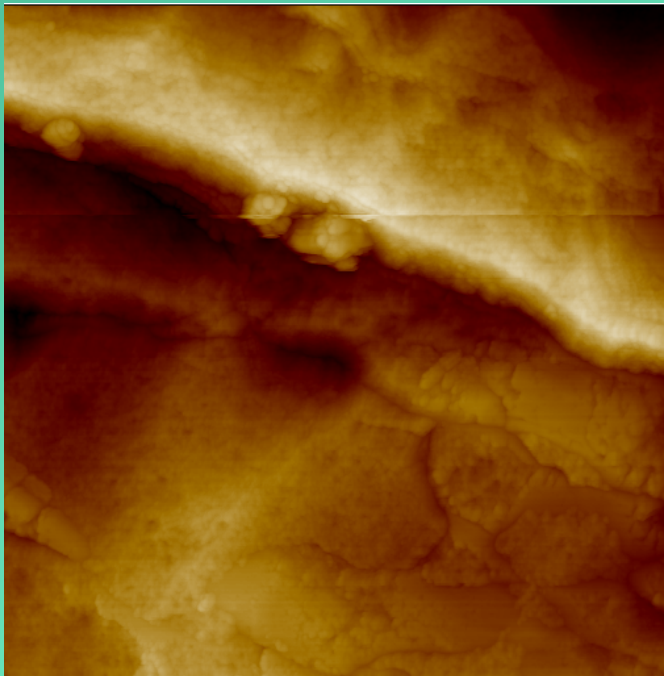


*between holes*



*10 μm scans*

*near hole*



1943 - 2004

**Alamos**  
National Laboratory

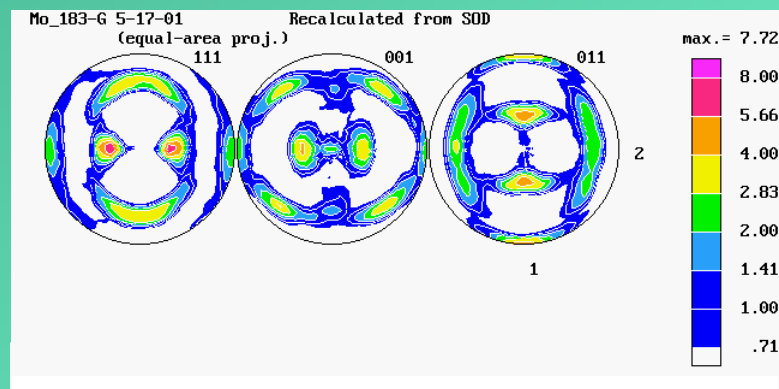
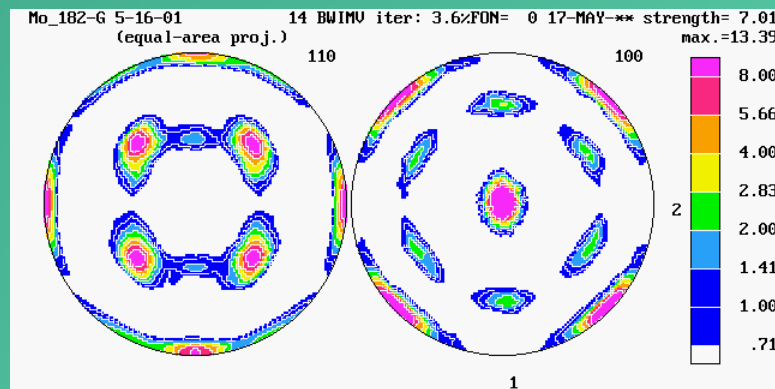
Ideas That Change the World



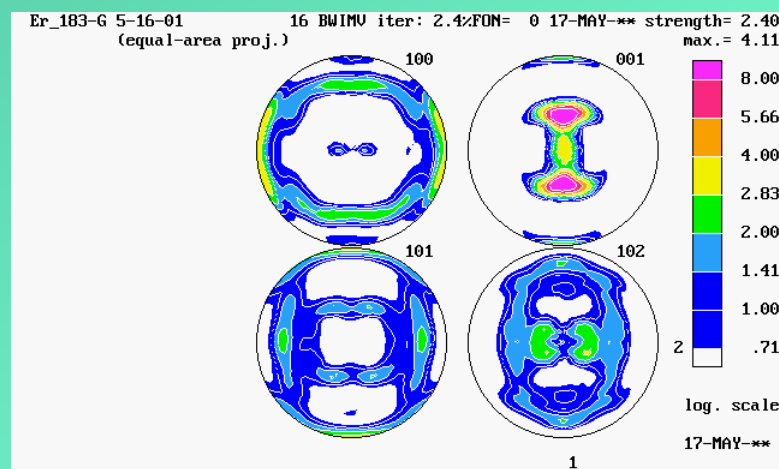
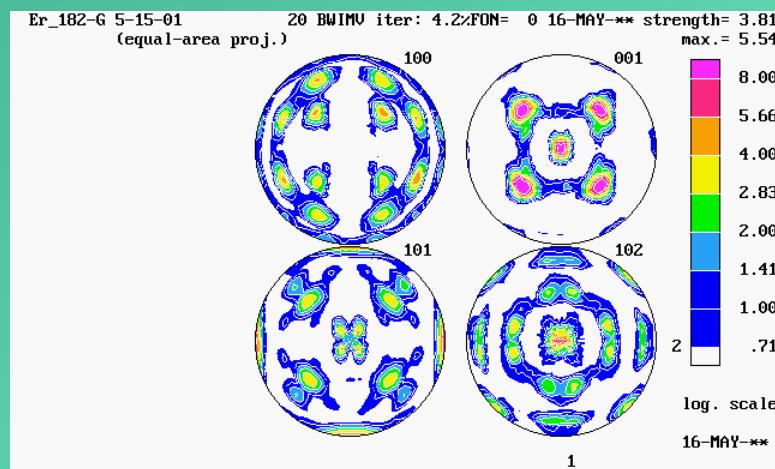
# As-Deposited Er on Mo Texture - Getters - John Bingert

## Er(001) to Mo(110) templating

Mo



Er



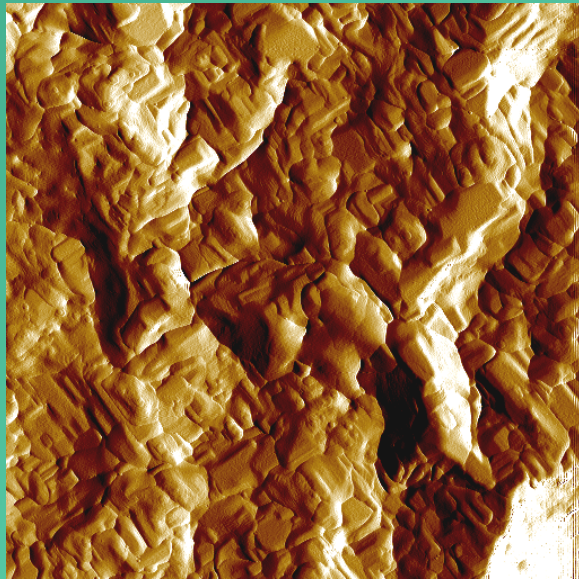
2993 Pinellas-like processing  
Getter (182)  
Mo(100) cube texture

4277 SNL processing  
Getter (183)  
either cross rolled or partially  
recrystallized  
Mo Texture

# *Relationship of the Erbium Film to Mo substrate*

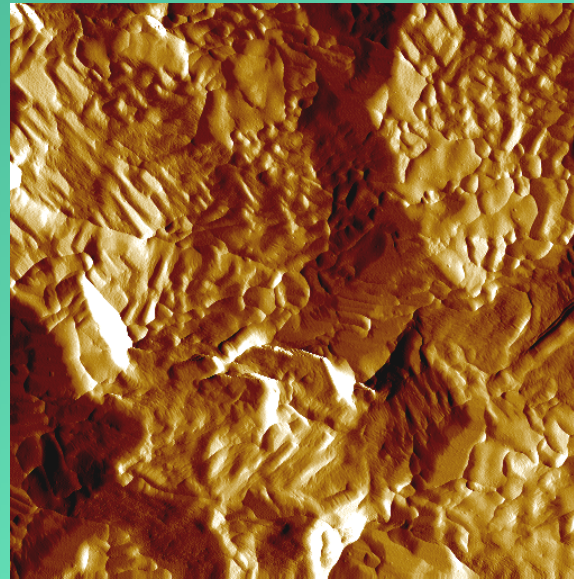
AFM 5  $\mu\text{m}$  x 5  $\mu\text{m}$  *phase* images

## *Getters*



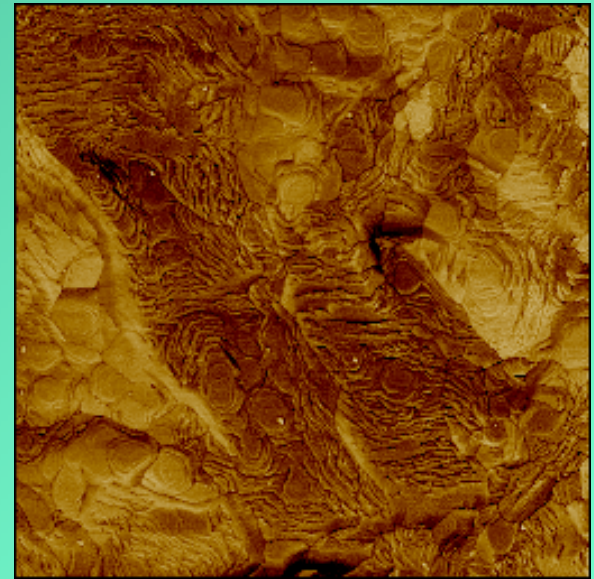
2993-182

Pinellas-like process



4277-183

SNL process

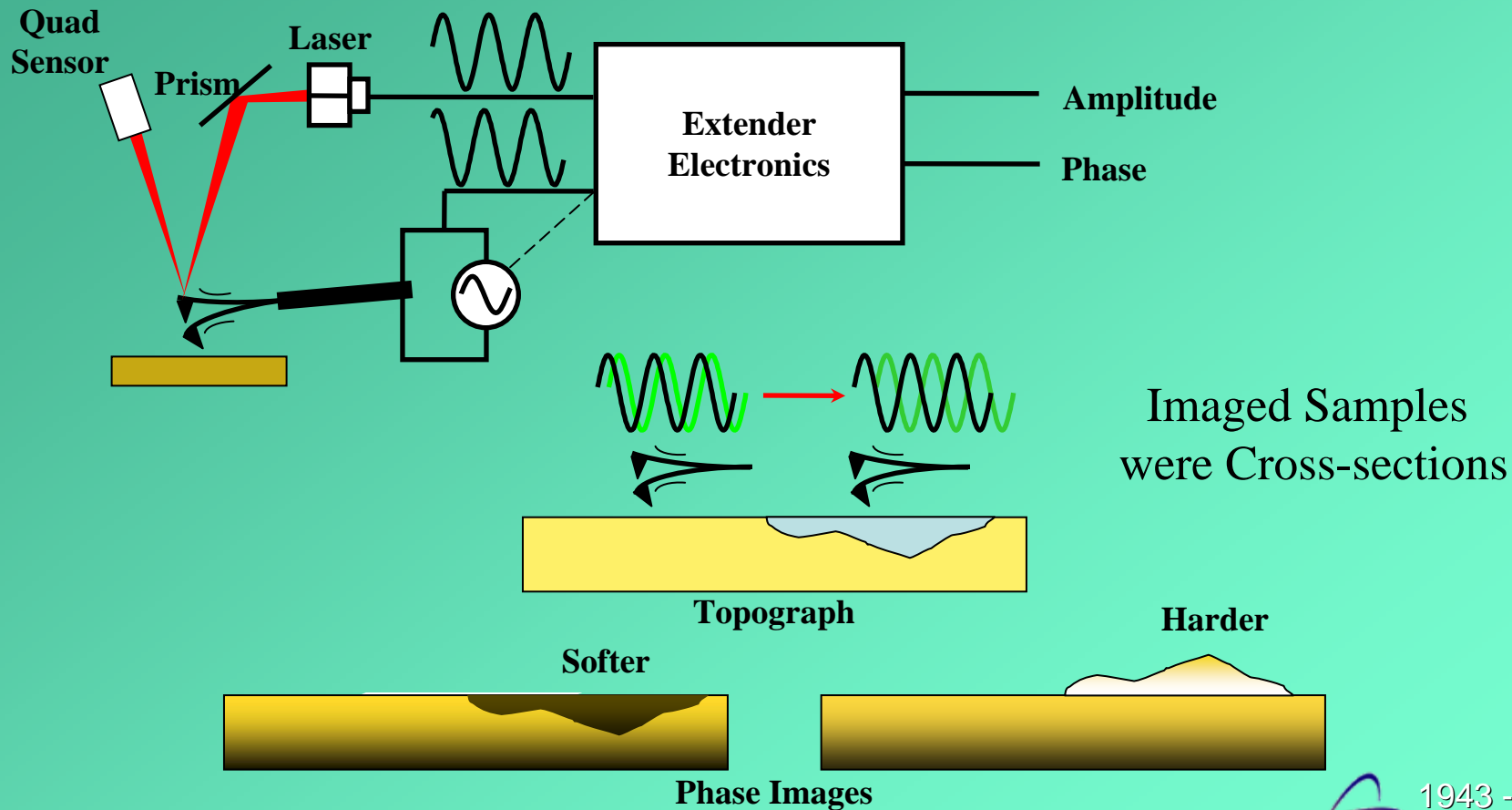


1051-016

*5.0  $\mu\text{m}$  scans*

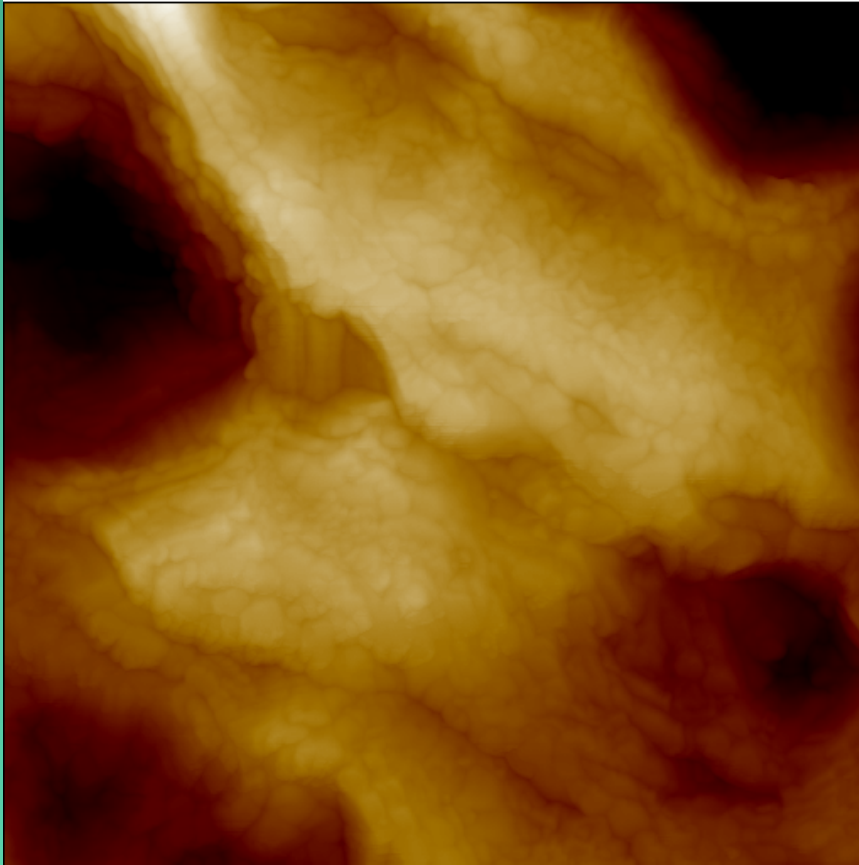


# Characterization - AFM Phase Imaging

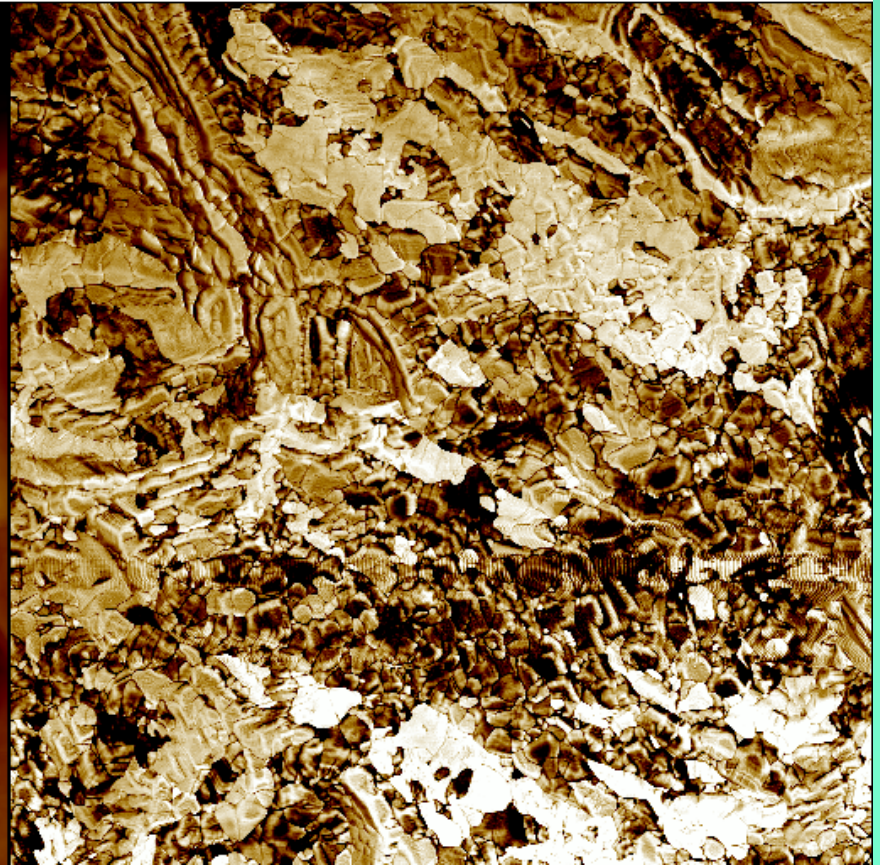


# *Characterization - AFM Phase Imaging*

Topograph



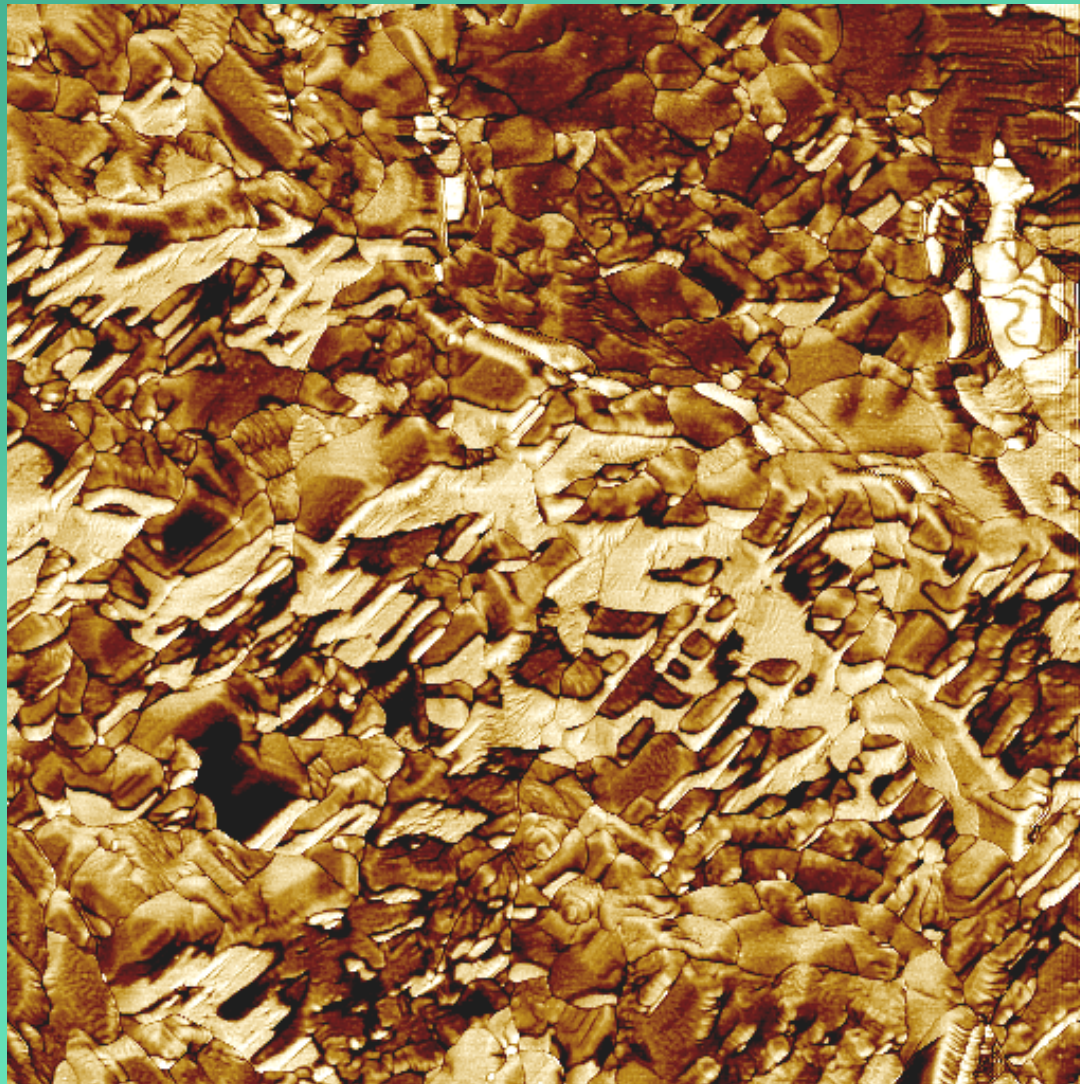
Phase





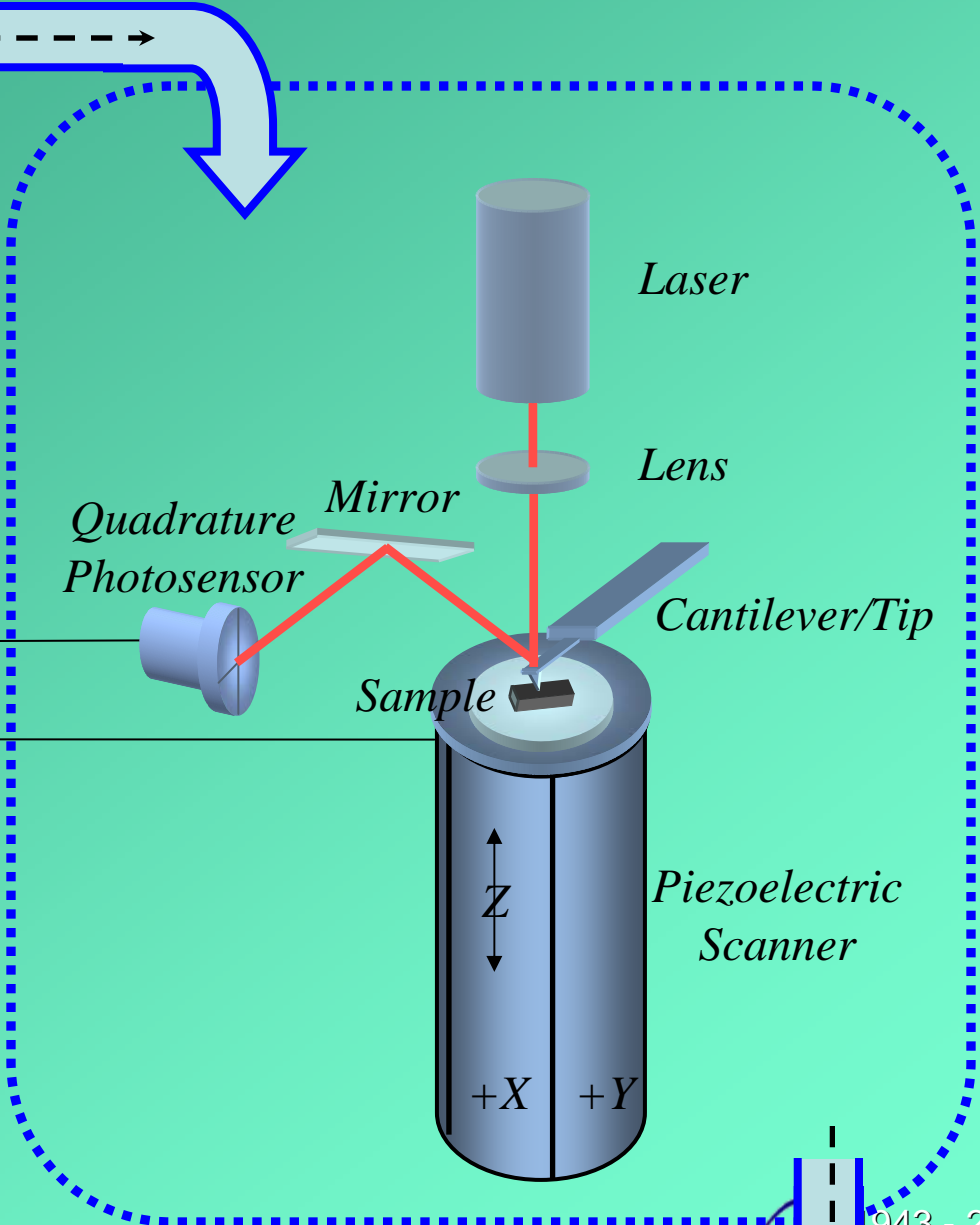
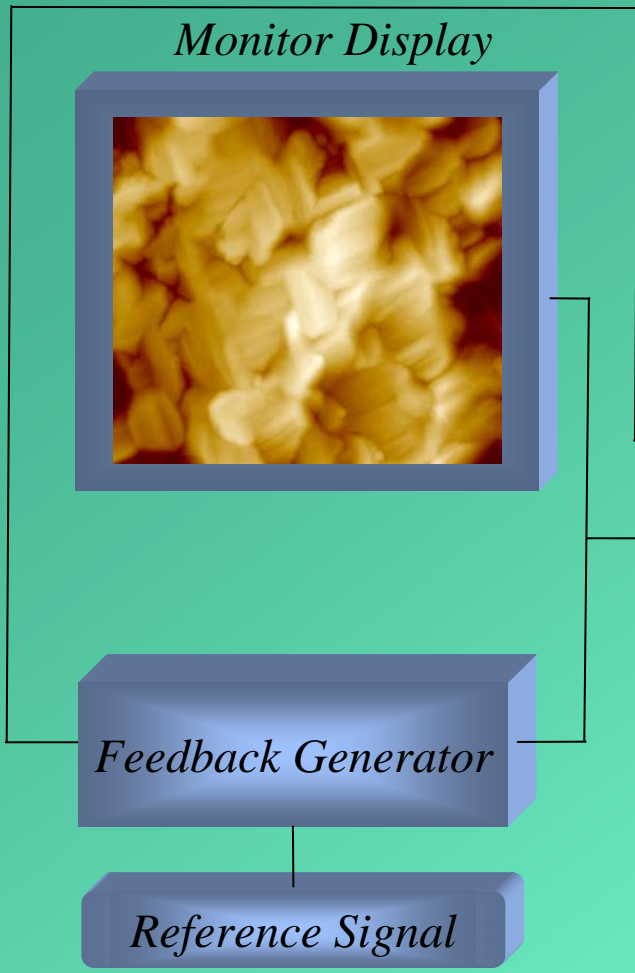
# *Characterization - AFM Phase Imaging*

Evap 1-181 Getter



*5.0  $\mu\text{m}$  scan*

Argon  $\dashrightarrow$



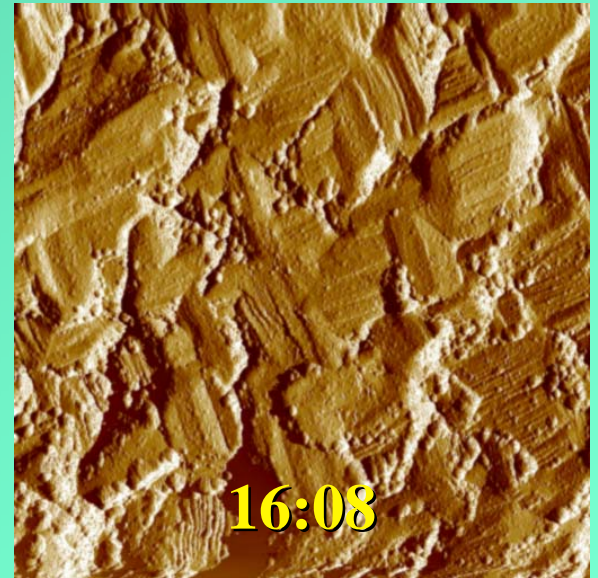
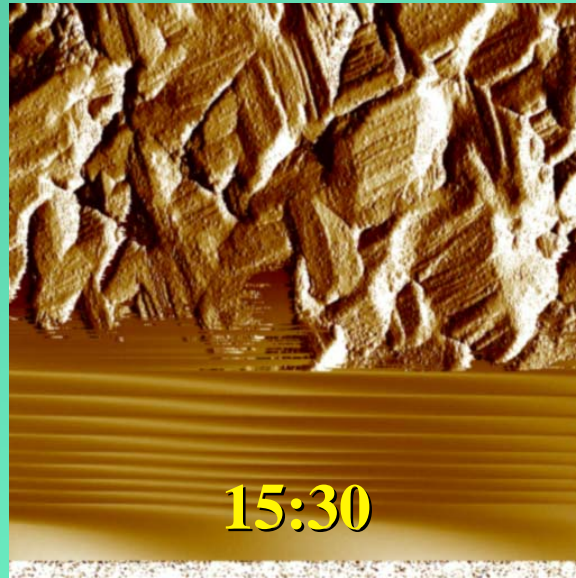
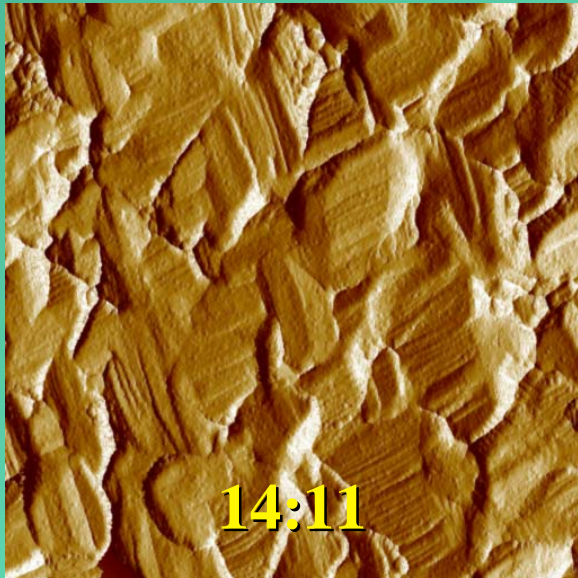
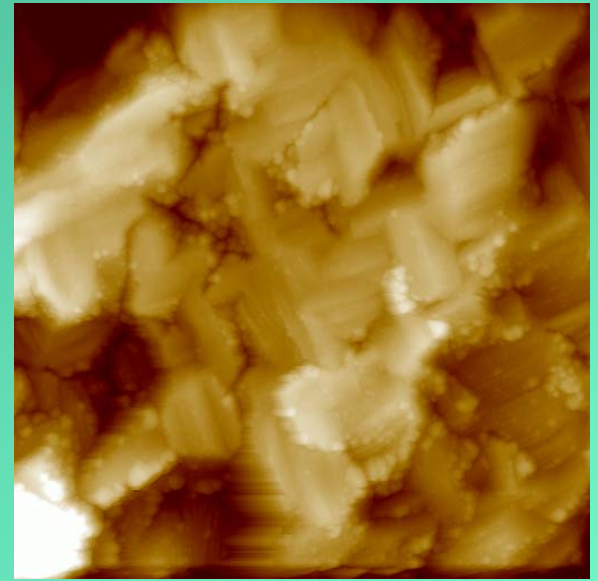
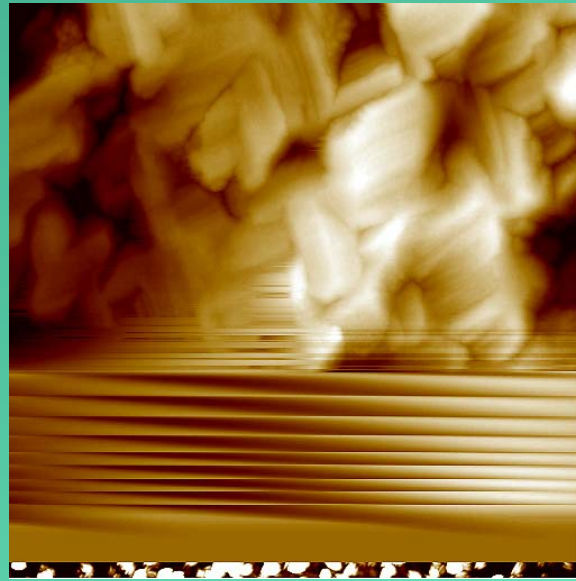
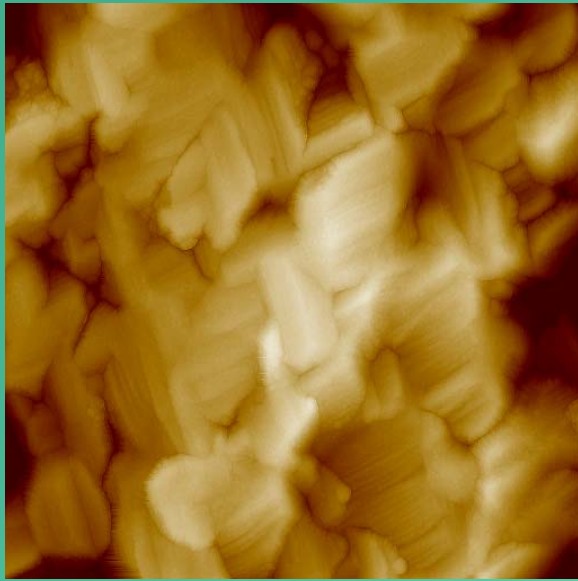
1943 - 2004

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Ideas That Change the World



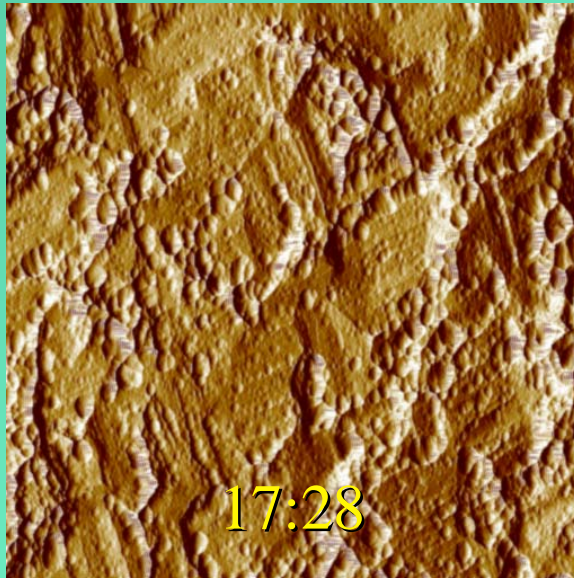
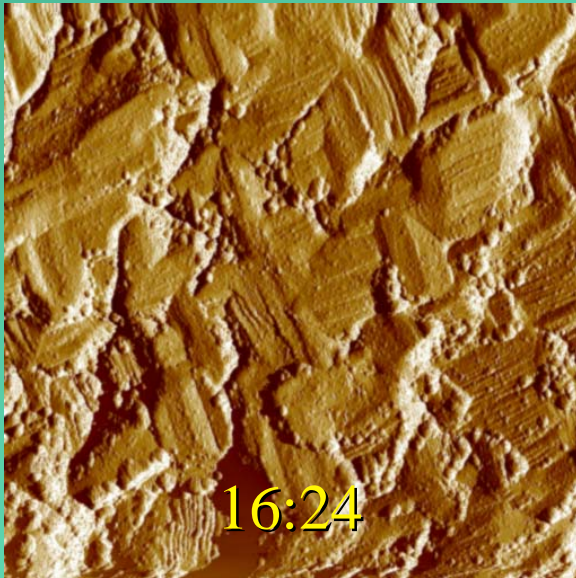
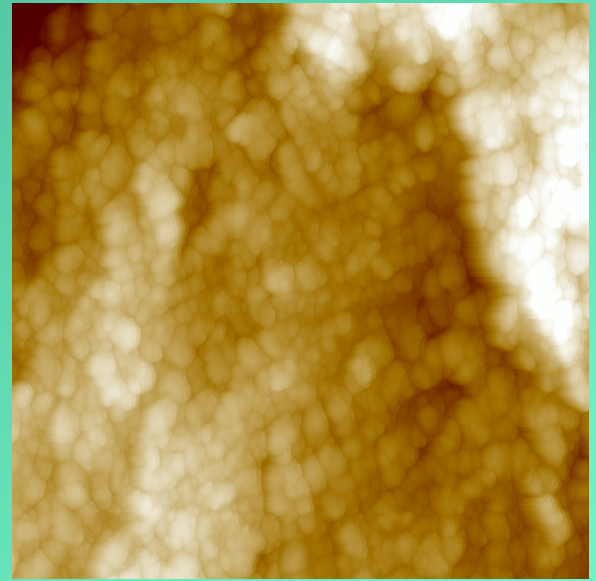
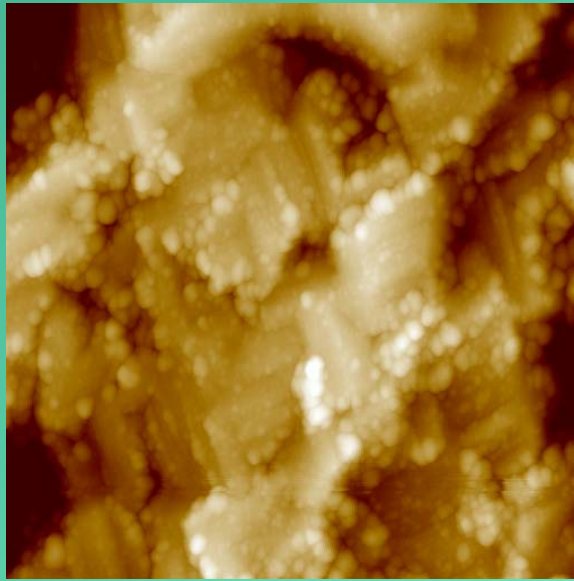
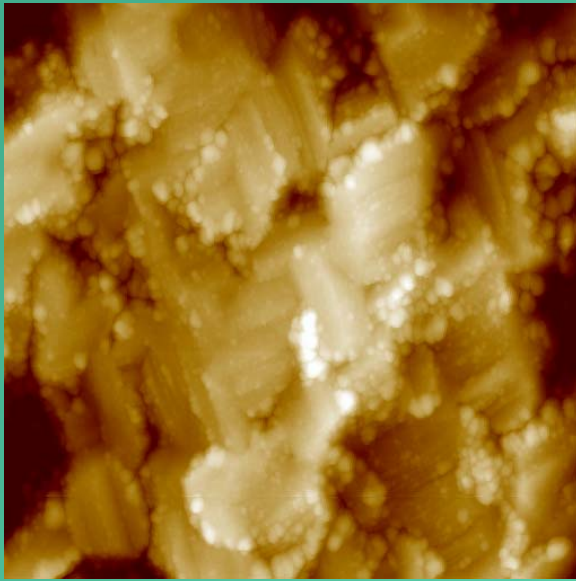


# Reaction Sequence - AFM Phase Imaging



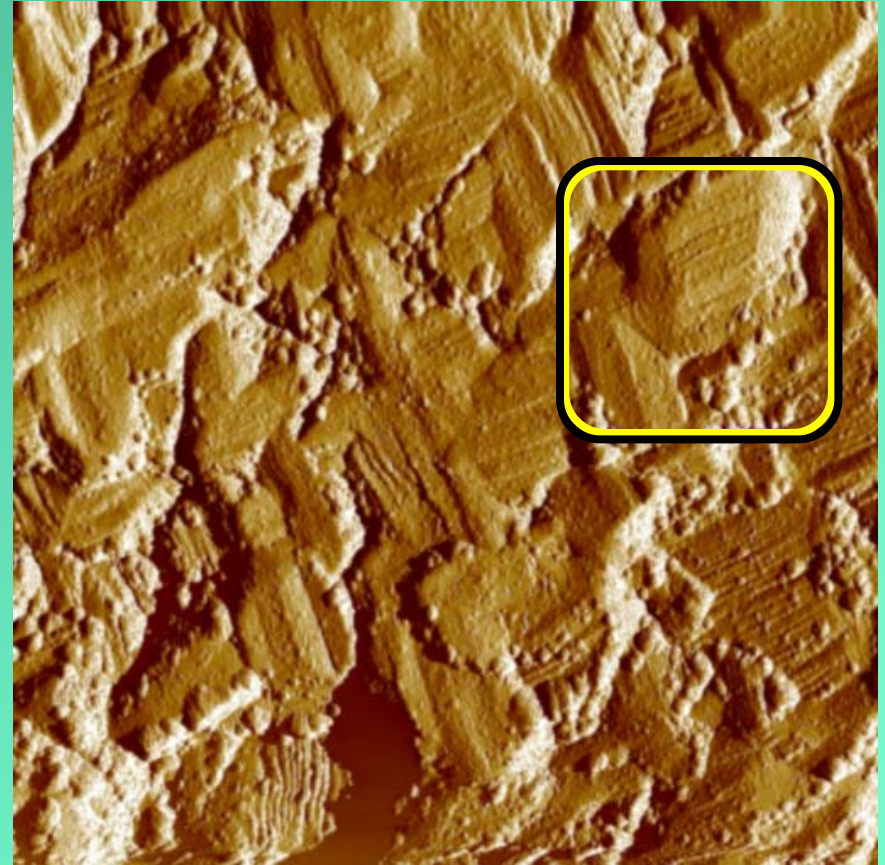
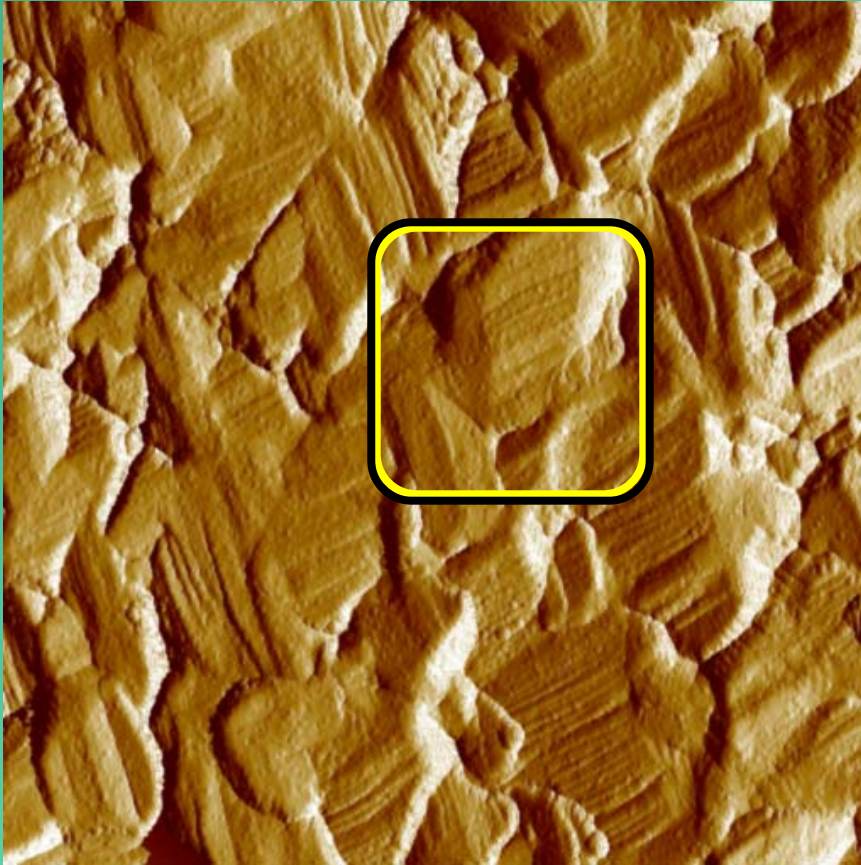


# Reaction Sequence - AFM Phase Imaging



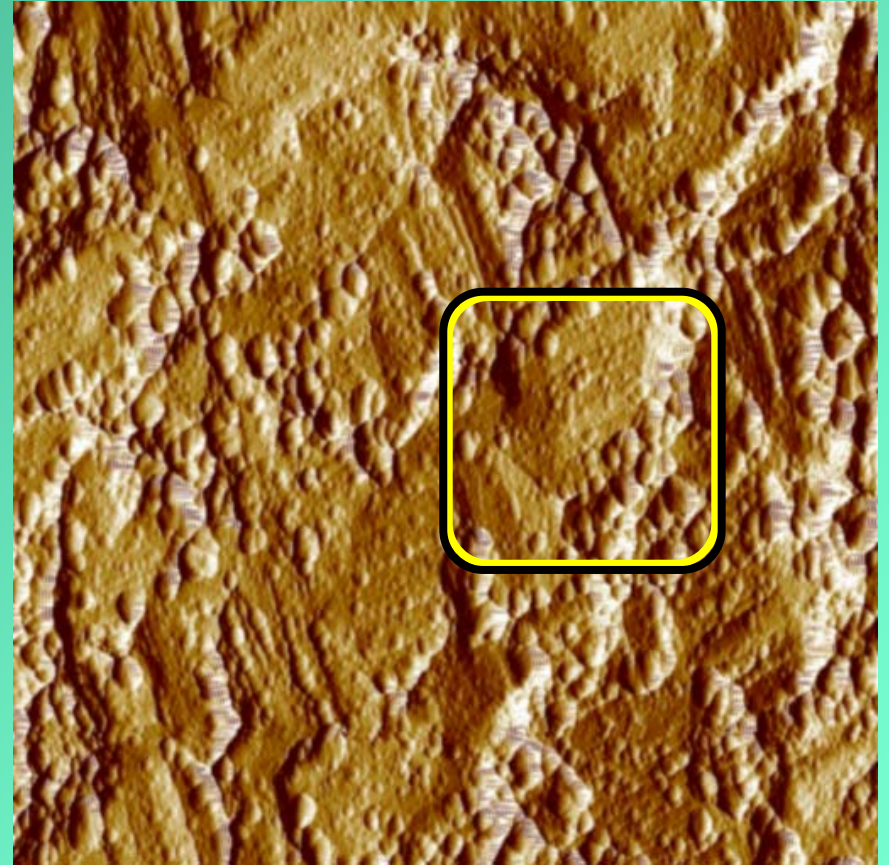
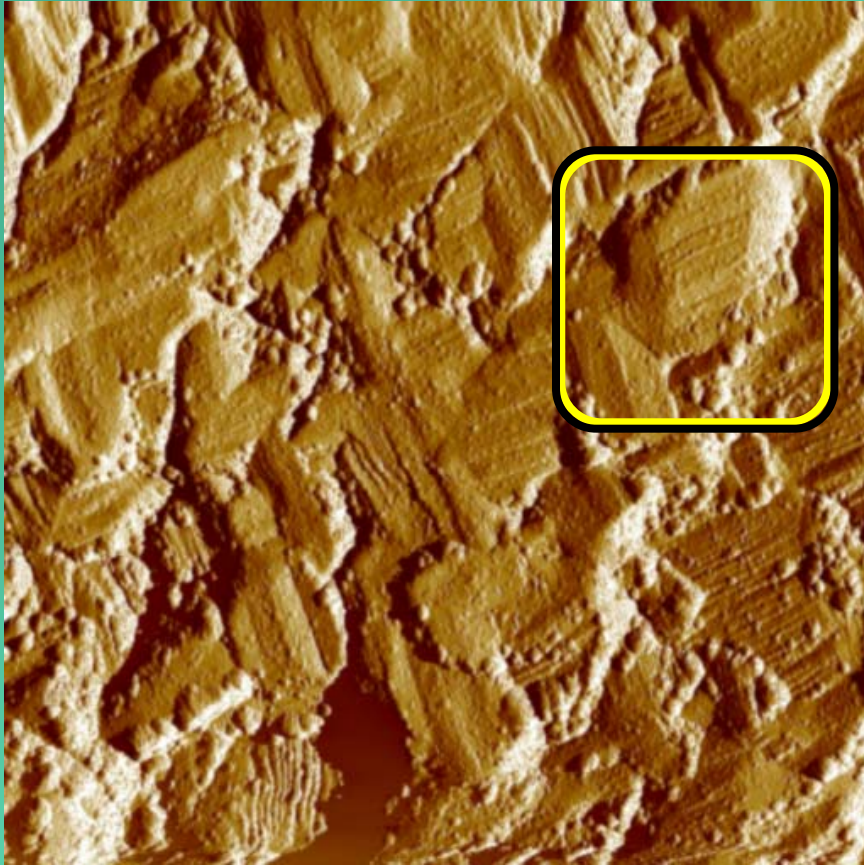


# *Reaction Sequence - AFM Phase Imaging*





# *Reaction Sequence - AFM Phase Imaging*





# *Ideas for future work*

Grow Er films *in situ* in UHV-STM system

*on single crystal substrates*

*with & without Mo buffer layer*

*on specially prepared Mo substrate (smooth)*

*expose film to H or D*

*use STM to study film structure & electronic properties, i.e.  $dI/dV$*

Grow Er films *in situ* in Roland's system

*on single crystal substrates*

*with & without Mo buffer layer*

*on specially prepared Mo substrate (smooth)*

*expose film to more realistic H or D pressures*

*& transfer to UHV-STM system via vacuum suitcase equipped with ion pump*

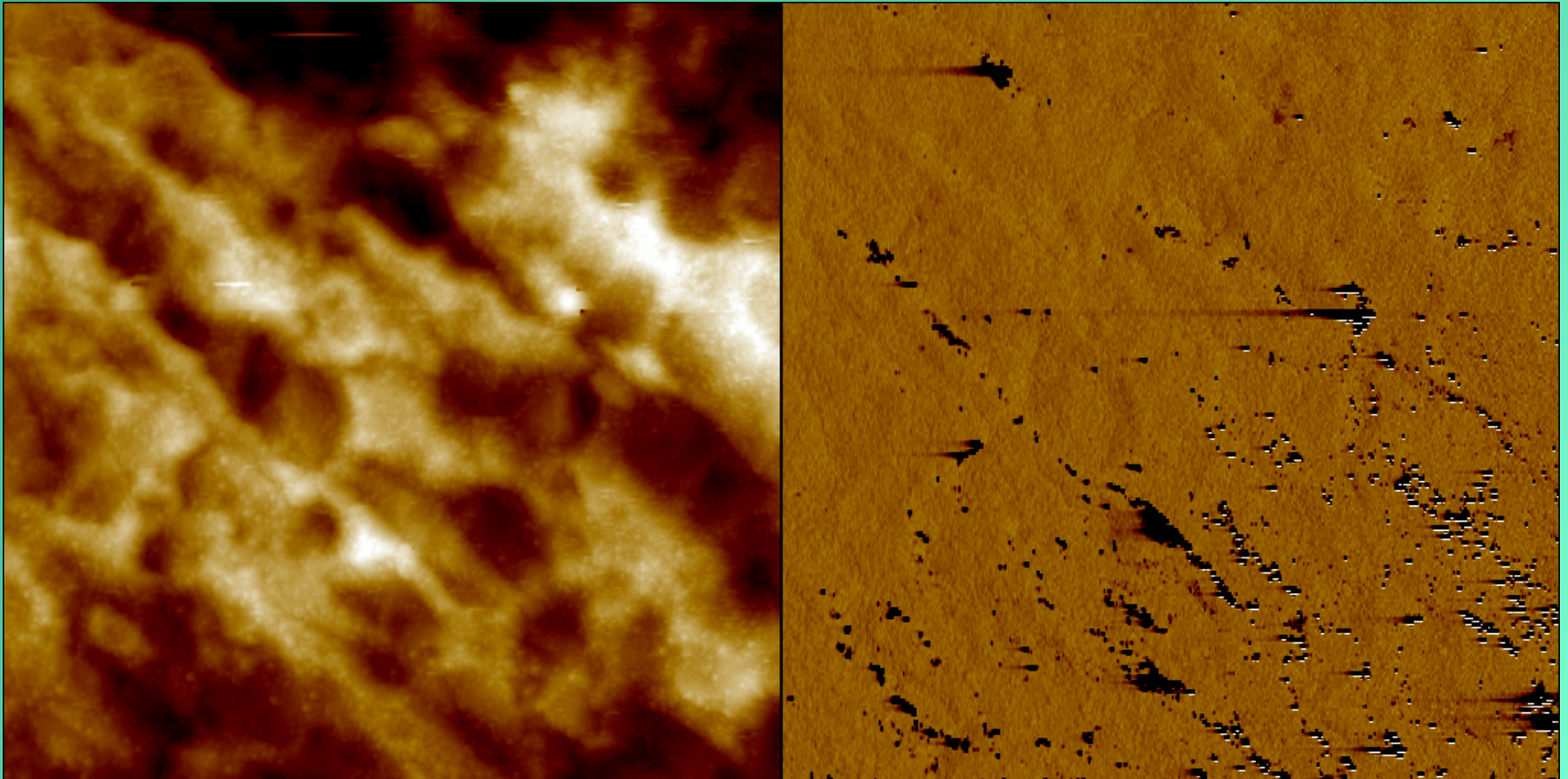
*use STM to study film structure & electronic properties, i.e.  $dI/dV$*



# *Tunneling AFM - TUNA*

Topograph

Tunneling Electrons



*30.0  $\mu\text{m}$  scan*

Brighter contrast - more Tunneling Electrons