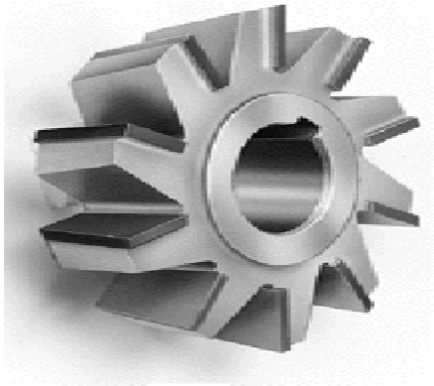
Part II

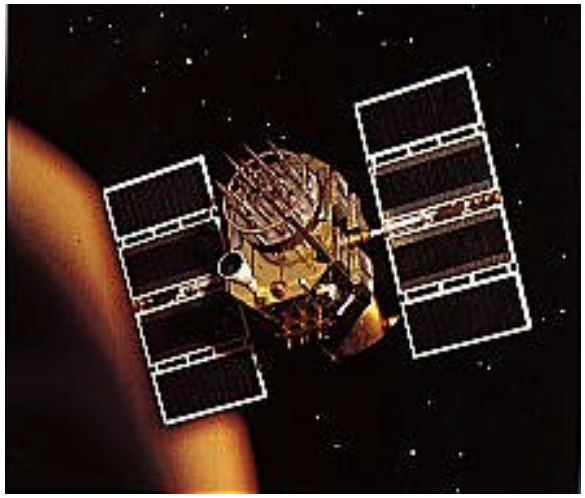
Chemical Modification of the Interfacial Frictional Properties of Vandium Carbide Through the Adsorption of Small Molecules



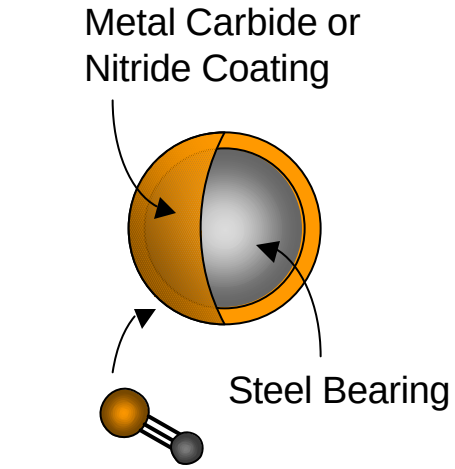
Motivation

- Transition metal carbides are useful in both physical and chemical applications
- Unique combination of physical properties
  - High melting/boiling points, hardness, conductivity
  - Attractive materials for wear resistant coatings
- Fundamental nature of interfacial properties largely unexplored
- Surface Tribology (friction and wear) provides fundamental information for the design of future satellite bearing systems

Surface Tribology of Metal Carbides



GPS Satellite on Orbit



APPROACH

- Define the fundamental surface reactivity and by studying single crystal materials from a surface analysis perspective.

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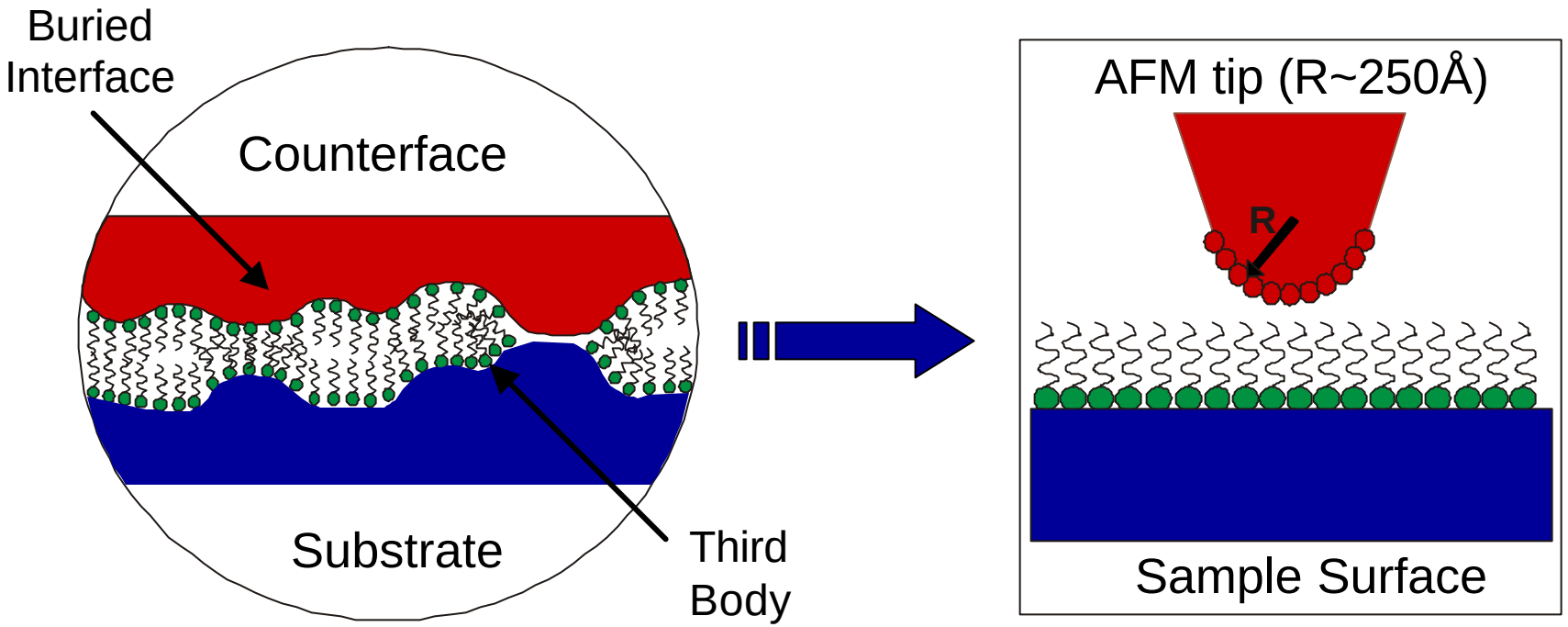
- which will exhibit reduced wear and enhanced lifetimes.

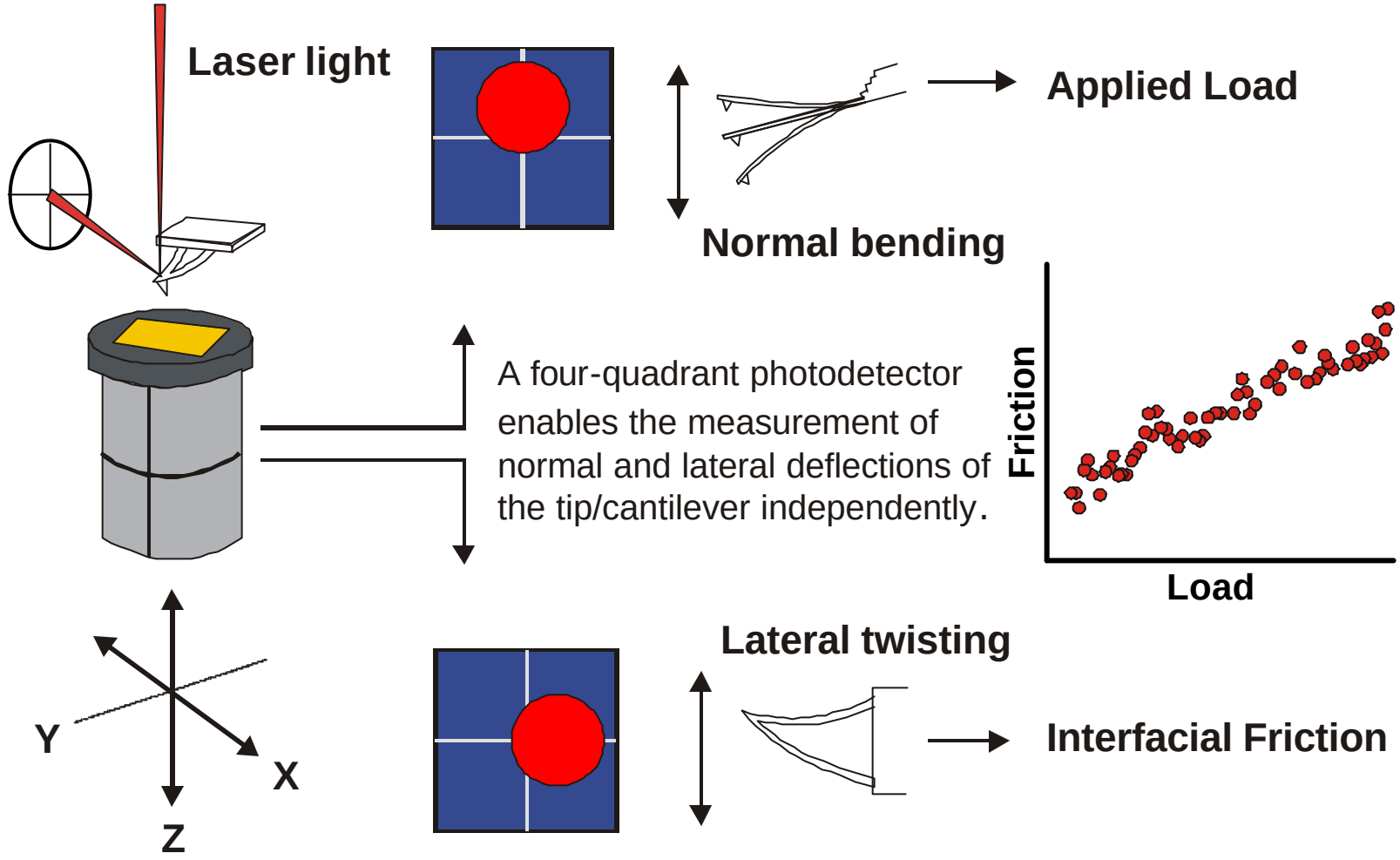
Fundamental Tribological Measurements



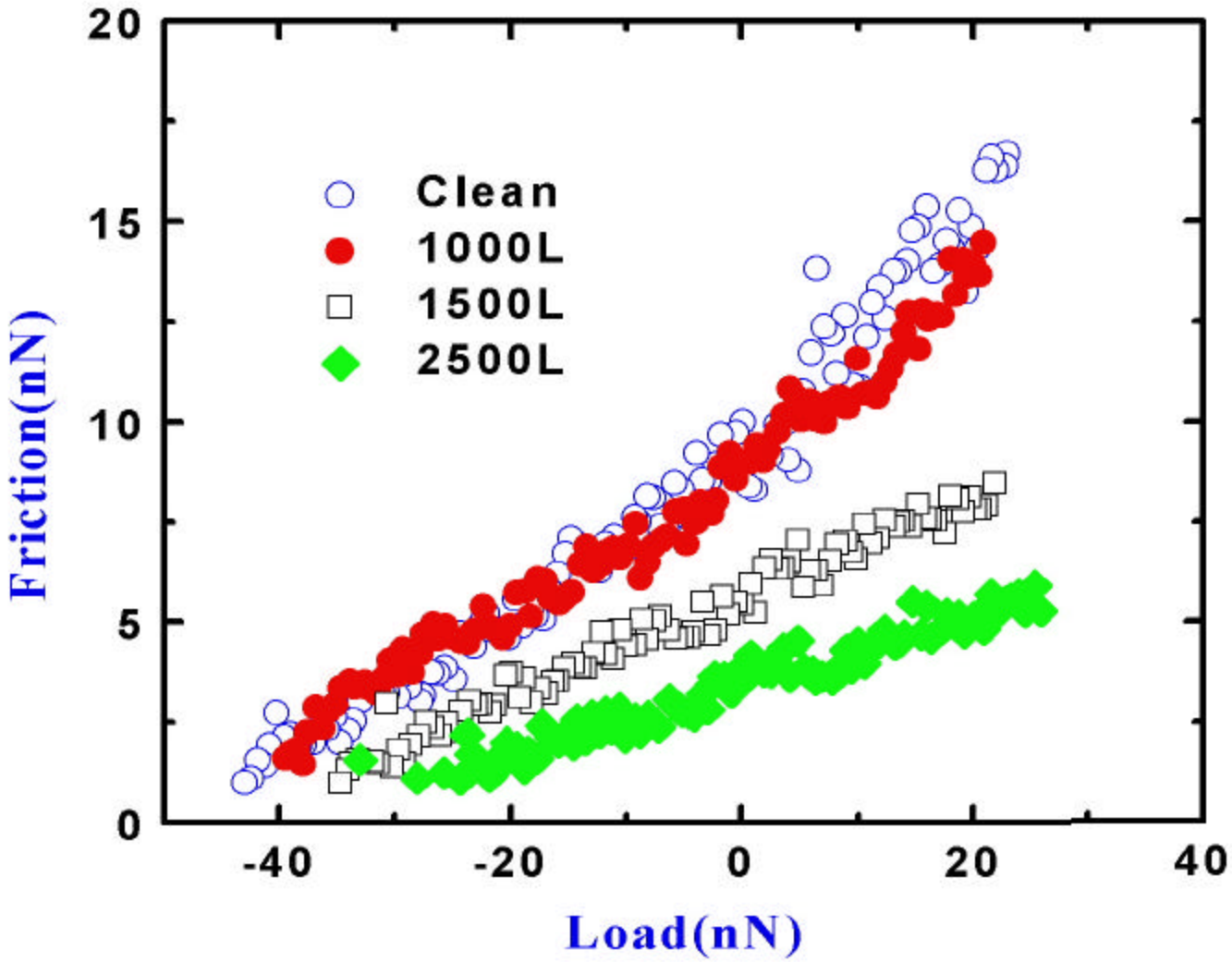
Microasperity Model of
Interfacial Contact

Single Asperity
Measurements with AFM

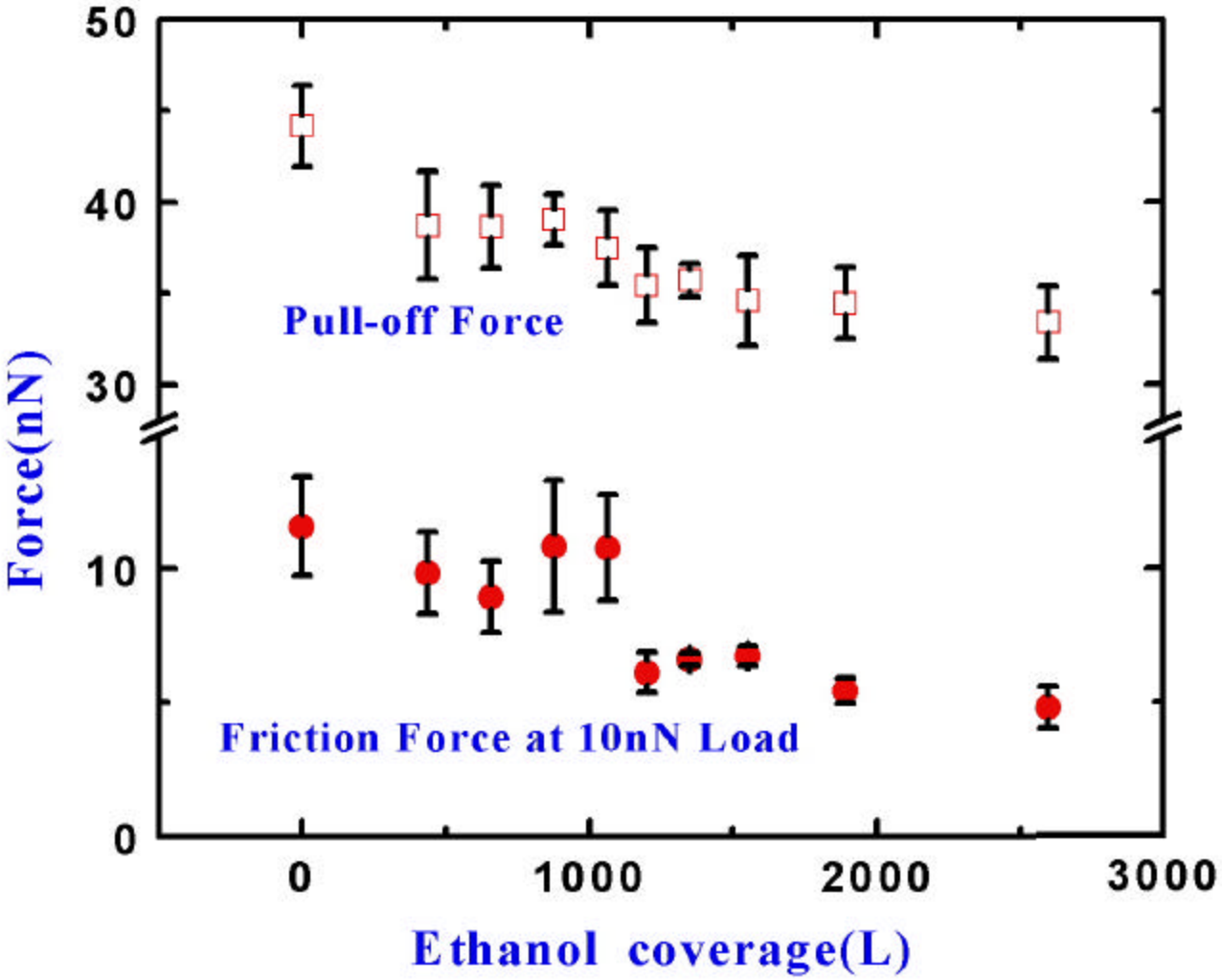
Friction Measurements with beam deflection AFM



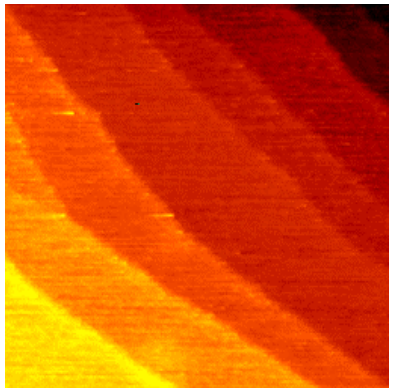
The Frictional Properties of Ethanol on VC(100)



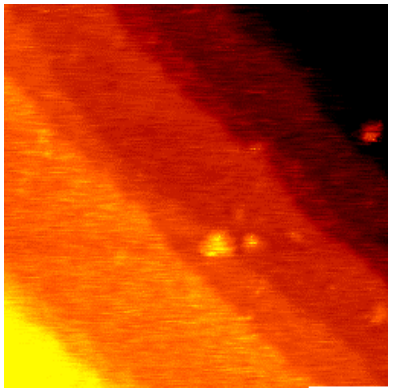
The Adhesion and Frictional Properties of VC(100) As a Function of Ethanol Exposure



The Growth Properties of Ethanol on VC(100)
STM Measurements of Reaction Film Growth

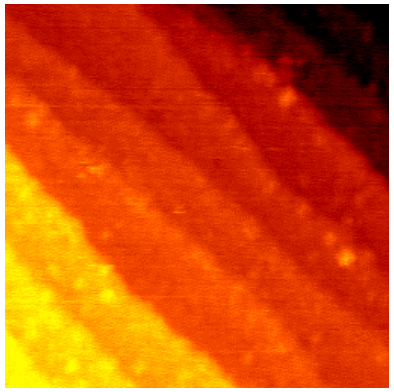


Clean

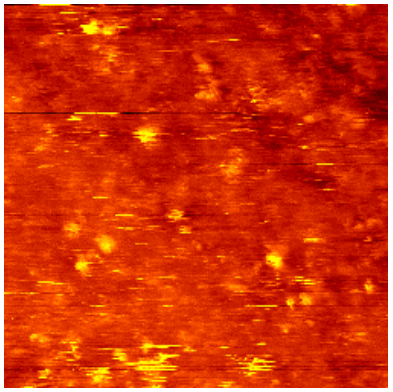


500L

(500Å× 500Å)

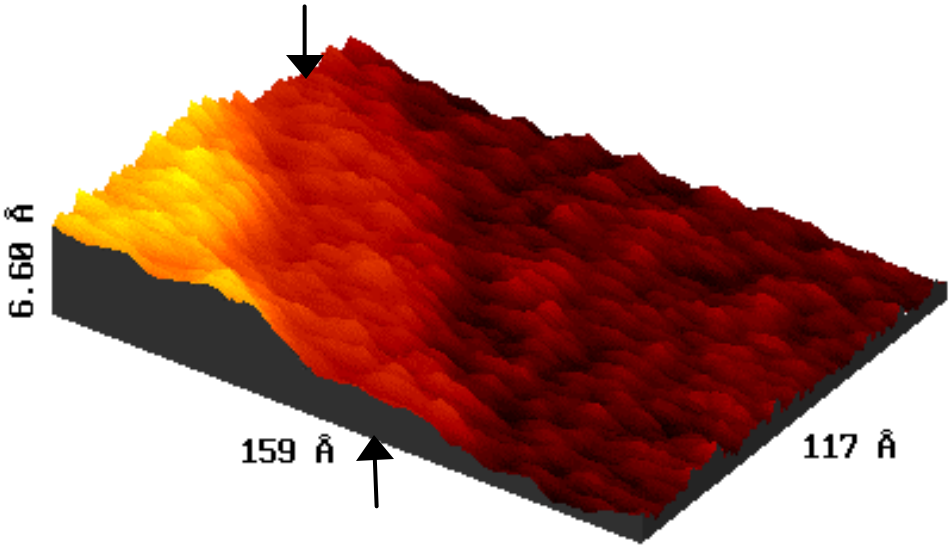


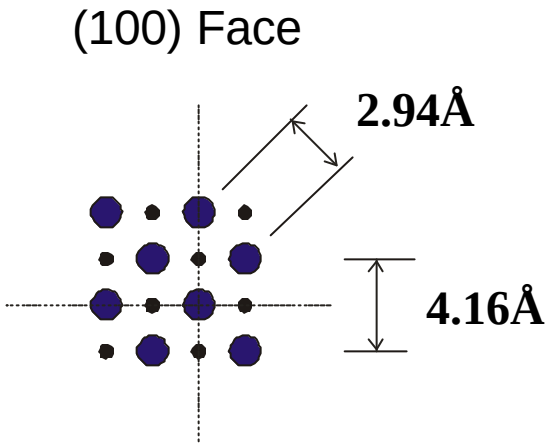
1500L

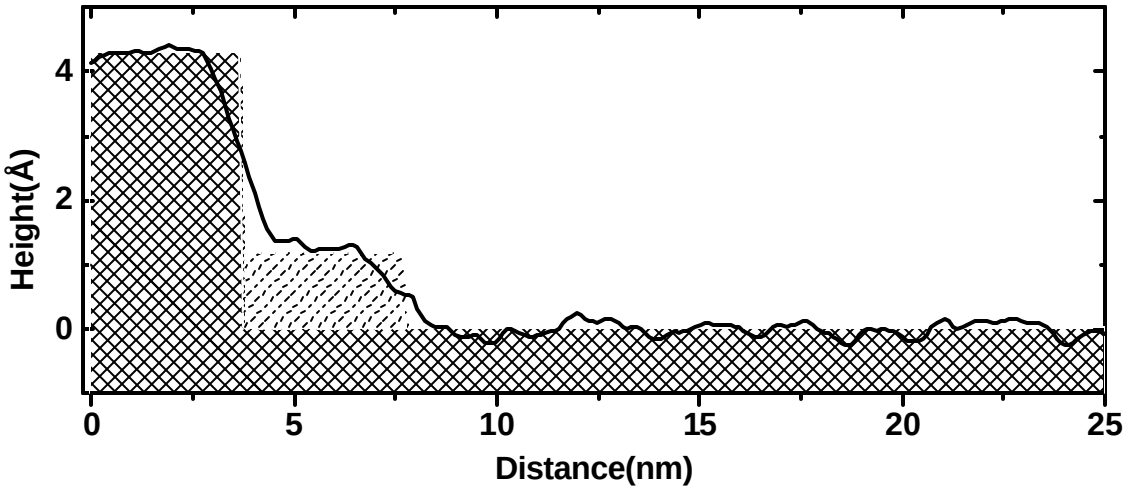


4000L

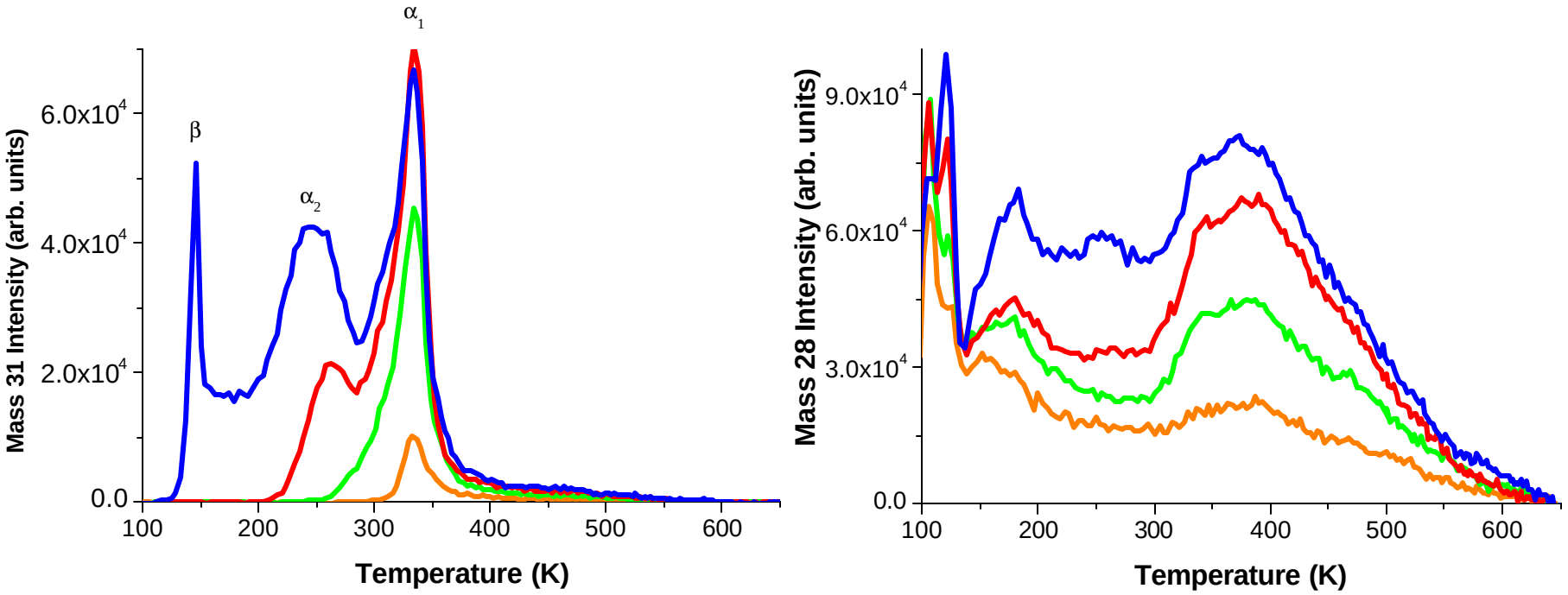
The Growth Properties of Ethanol on VC(100)
STM Analysis of Reaction Film Growth





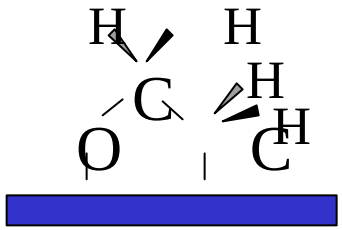


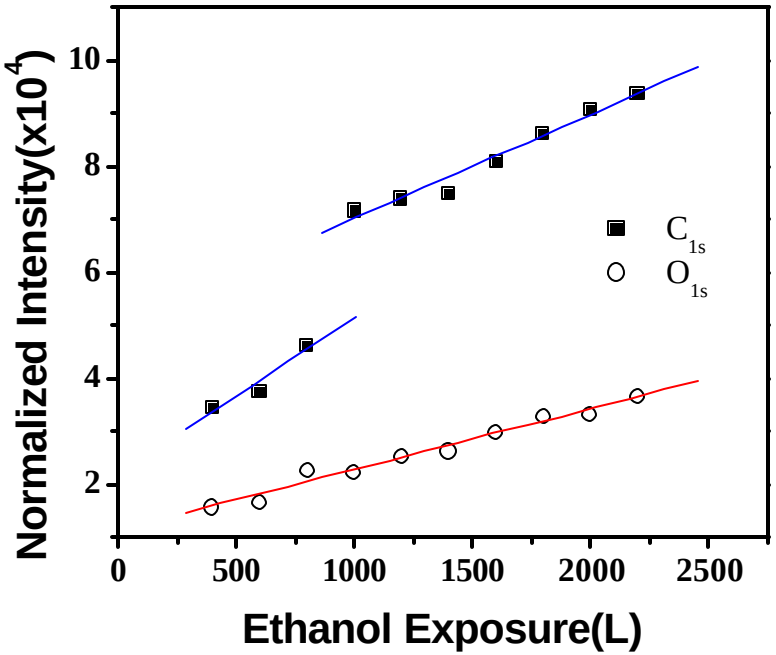
TPD of Ethanol from VC(100)

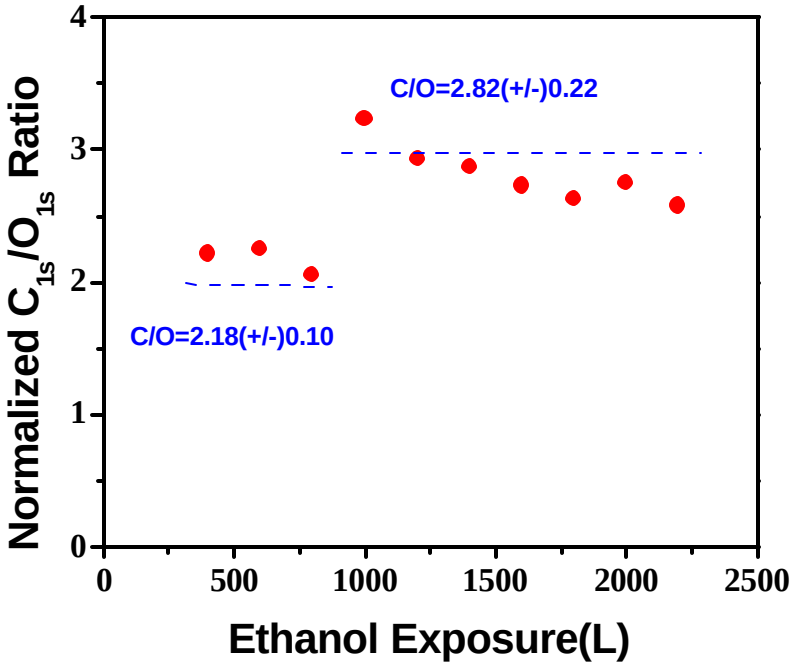


- Both molecular and recombinative desorption of the alcohol is observed
- Ethene evolution (verified with isotopically labeling studies) is detected over the temperature range 300-600 K

The Growth Properties of Ethanol on VC(100)
XPS Uptake Measurements



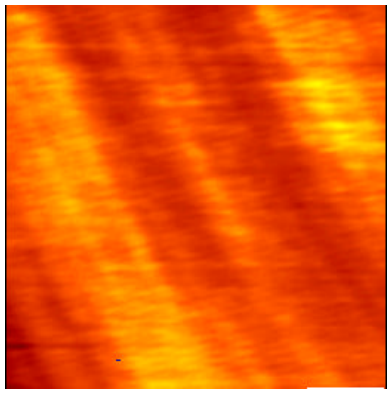




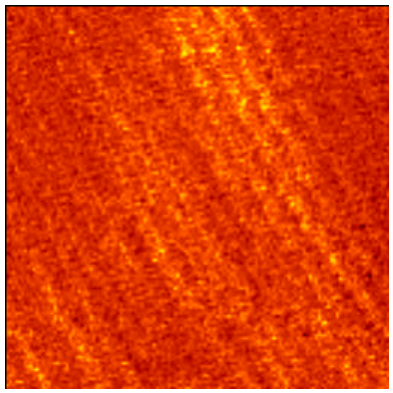
The Growth Properties of Ethanol on VC(100)
AFM Imaging Study

Before Ethanol Dosing

Topography(rms:2.5Å)

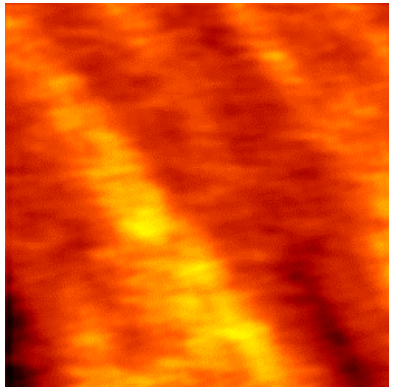


Friction image (rms:9.8nN)

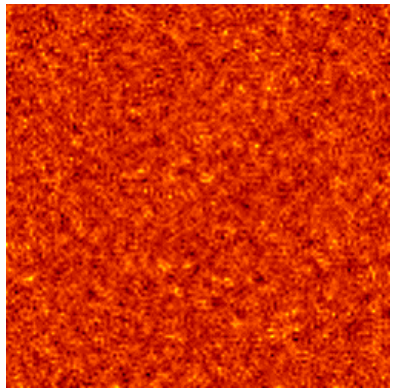


After Ethanol Dosing (1500L at RT)

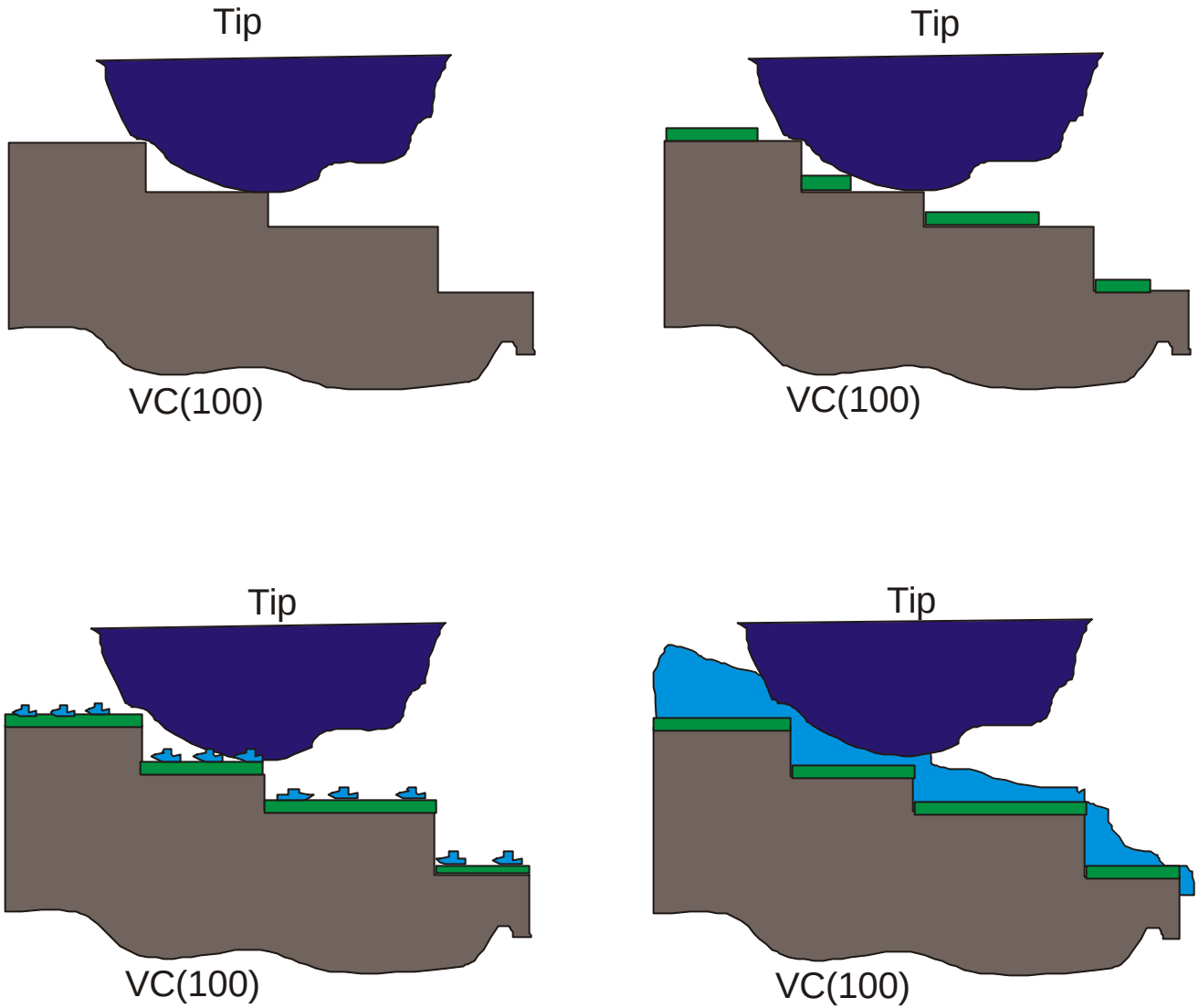
Topography(rms:1.8Å)



Friction image (rms:5.1nN)



Chemical Modification of the Frictional Properties of VC(100)



Conclusions

Dissimilar changes in friction and adhesion are observed.

Friction reduction is correlated to the completion of a monolayer of a reaction layer.

Chemical Modification of the carbide surface inherently lower interfacial shear strength.

Demonstrates possibility of vapor phase lubrication of metal carbides