Professor Lynn S. Penn

Surfaces and Interfaces: Design, construction, and evaluation

We change the physical chemistry of surfaces to change the surface properties

Why change?
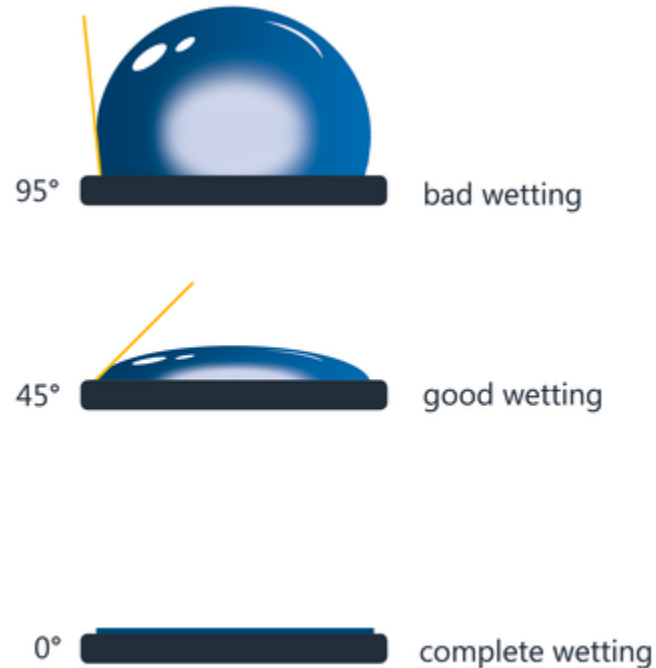
- Repel other species –
  - *Reduced friction,*
    bbbb
  - *Repelling dirt,*
  - *Preventing blood clots*

- Attract other species –
  - *Improved adhesion,*
 - *Selective trapping for analysis,*
  - *Trapping to purify*
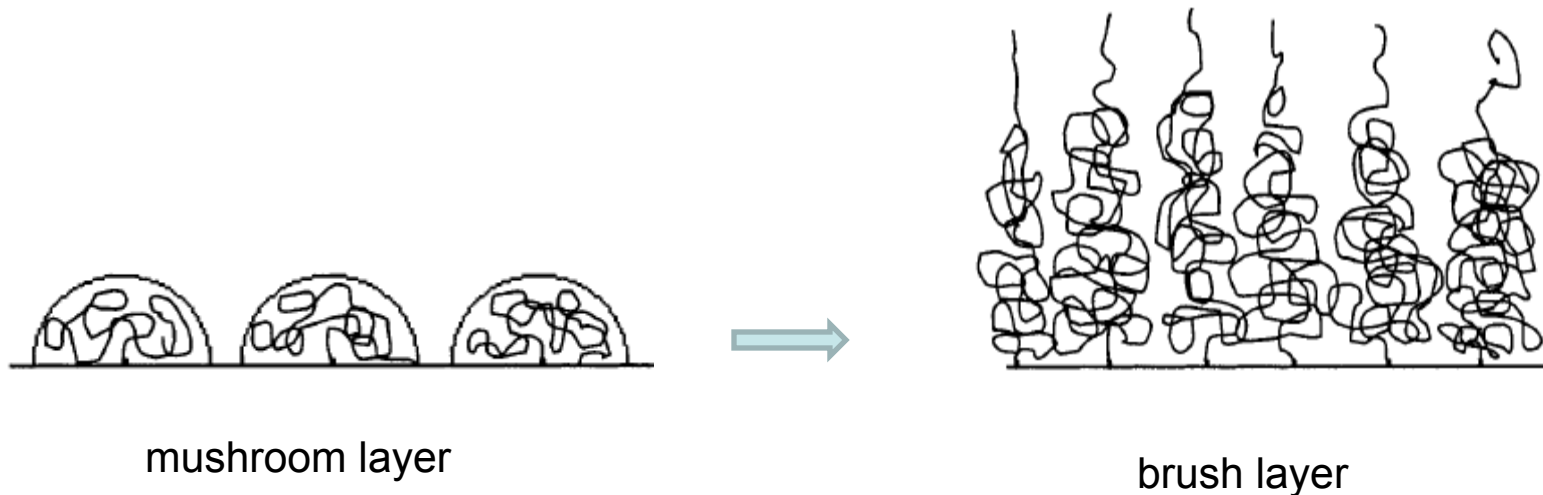
Because surface regions occupy very little volume, qualitative and quantitative analyses are challenging

Contact angle measurements are no longer sufficient

95° bad wetting

45° good wetting

0° complete wetting
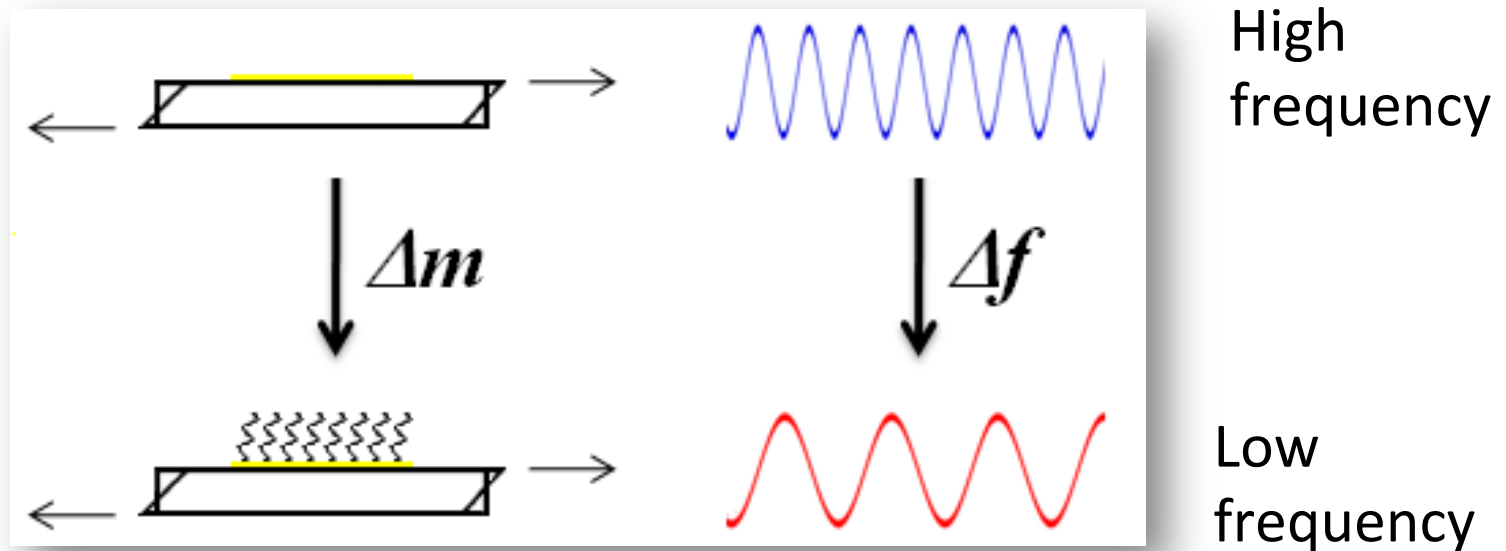
Case study: development of a polymer brush on a solid surface

- We determined that the spontaneous development of a polymer brush is a step-wise process


mushroom layer

brush layer
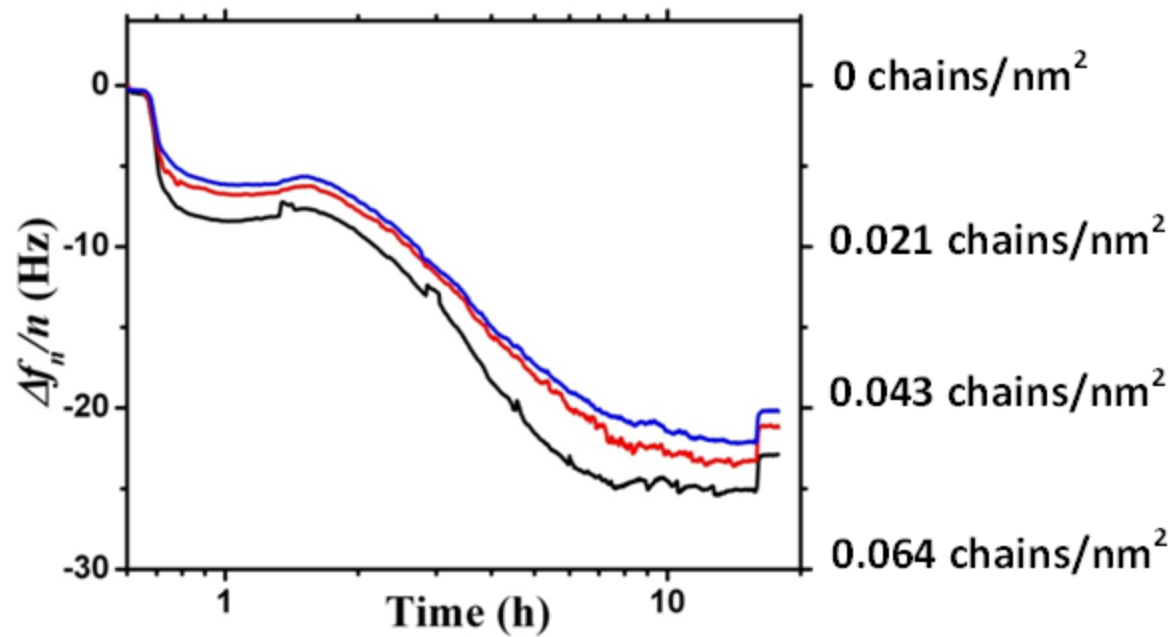
Quartz crystal microbalance, based on the change in resonant frequency when mass is added to a sensor crystal, provides quantitative analysis throughout the development
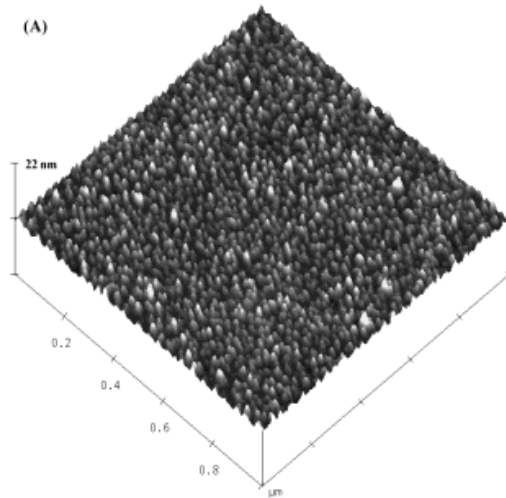
Nanogram sensitivity to changes in mass and mass distribution on solid surface of a piezoelectric sensing element

High frequency

Δm

Δf
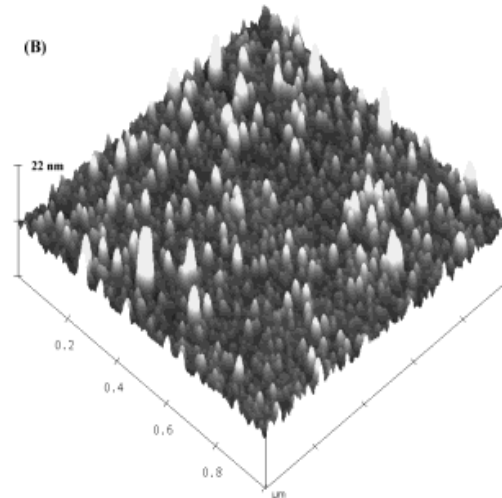
Low frequency

Frequency change shown by QCM shows brush development process to be step-wise
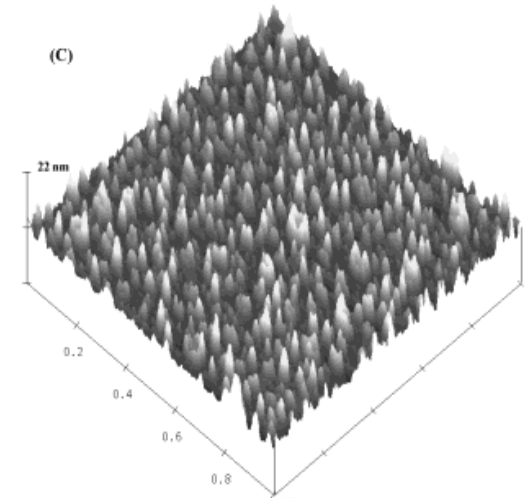
Atomic force microscopy (AFM) provides detailed surface topography and shows that transition from mushroom to brush is not spatially uniform, suggesting autocatalysis


Mushroom, smooth and uniform

Transition from mushroom to brush, note spotty areas of polymer extension
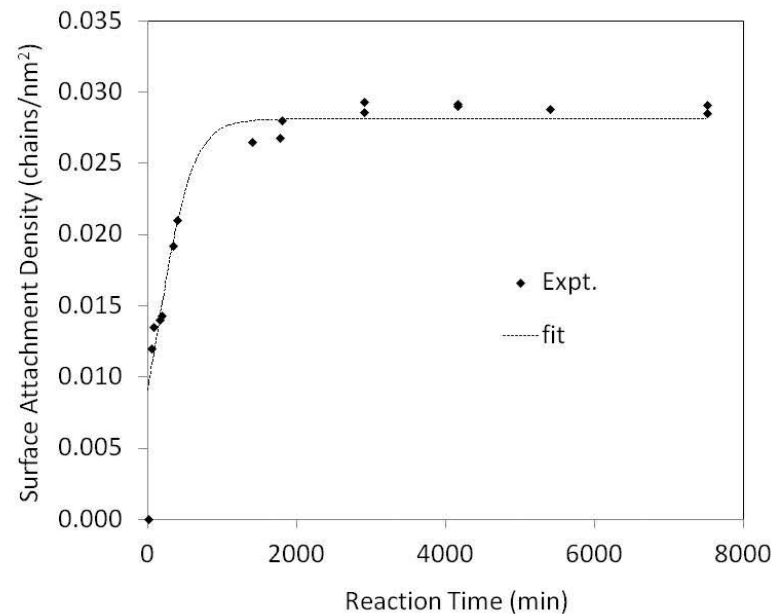
Brush, polymers now all extended away from surface to which they are grafted

Calculations showed that the transition from mushroom to brush is autocatalytic, as suggested by the spatial nonuniformity

$$B(t) = \frac{A_0 + B_0}{1 + \dfrac{A_0}{B_0}e^{-k(A_0+B_0)t}}$$

Data points fit the curve of the equation:

Theme is surfaces and interfaces

- Design – use your imagination and your knowledge of chemistry and physics

- Construction – do chemistry in the lab

- Evaluation - most difficult, requires multiple techniques