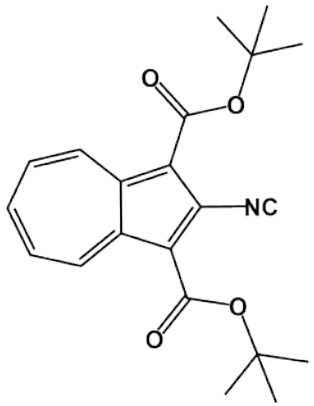
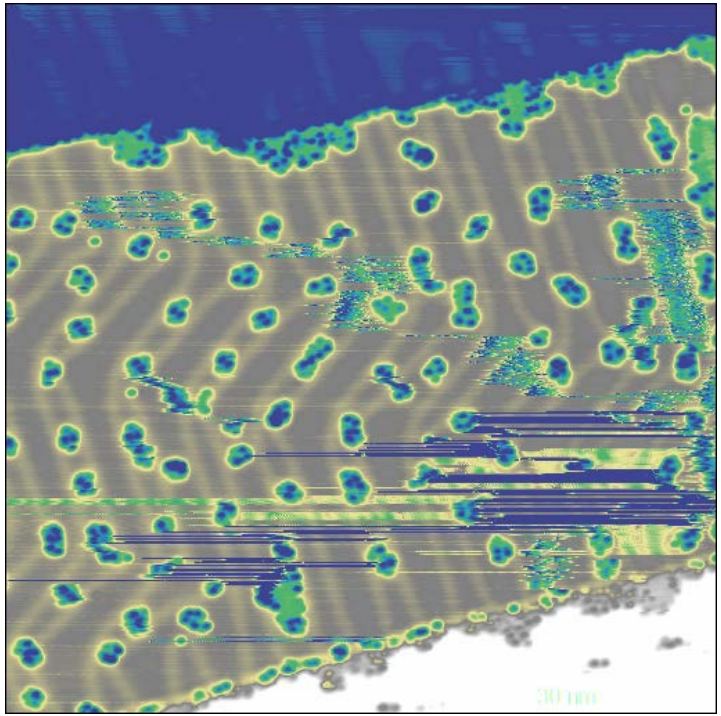


di-*tert*-butyl 2-isocyanoazulene-1,3-dicarboxylate

evaporation: 30s @ 110°C

STM Image: (80nm)², 21 pA, 0.5 V

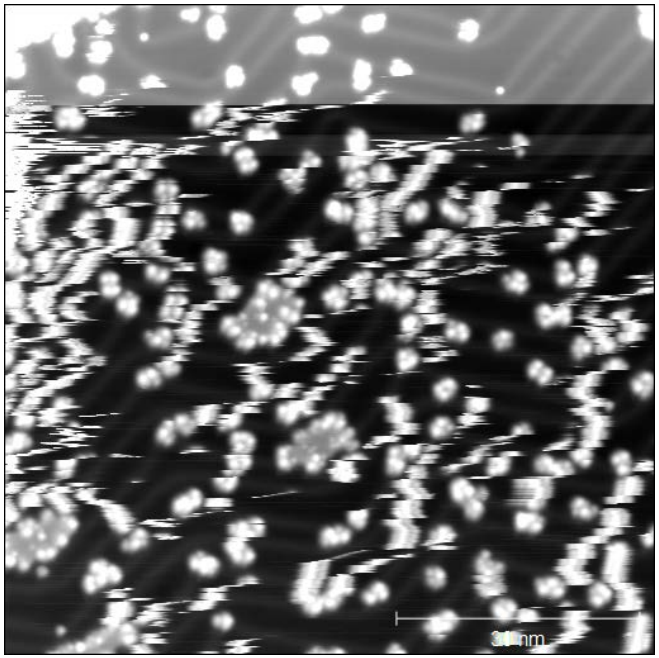


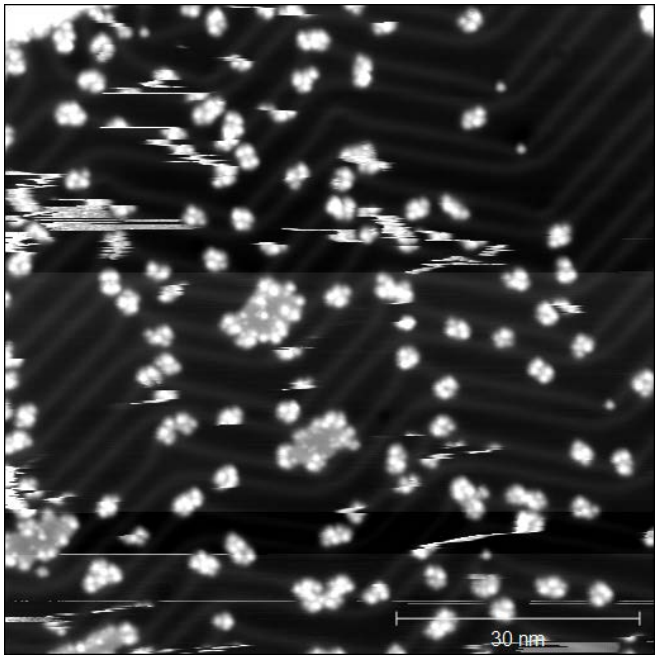
- Molecules on Au(111)
- Rests of of solvent, broken molecules
- Single molecules cannot be found
- Several common (dimer) species

Scanning:

(80nm)², 18 pA, 0.5 V

1st scan





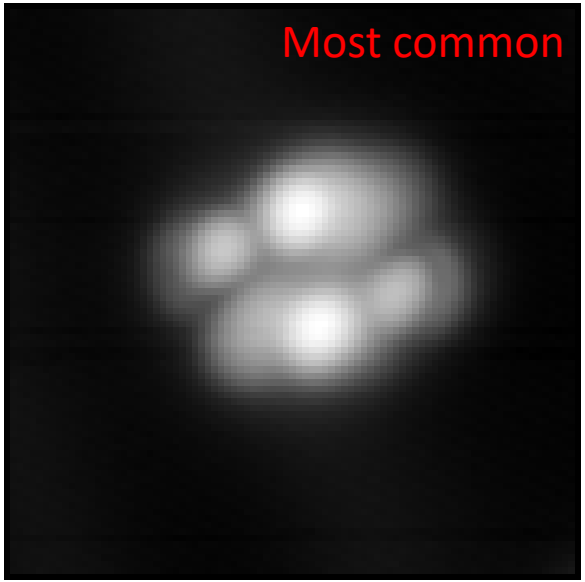
2nd scan

The molecules are pretty mobile at the surface, standard topography already „cleaning“ the surface partially

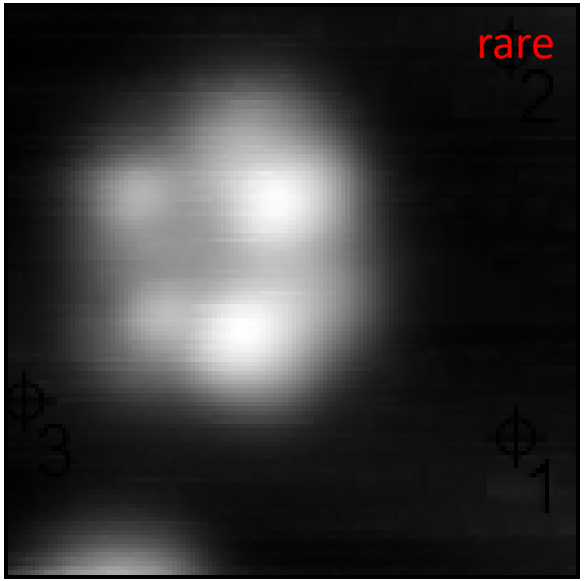
➔lateral movement possible, but isolation of single molecules not

Different observed dimer structures:

All images of size $(5\ nm)^2$



20 pA, 0.25 V

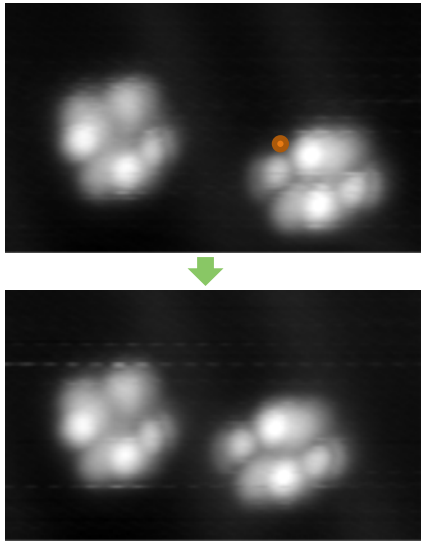


40 pA, 0.2 V

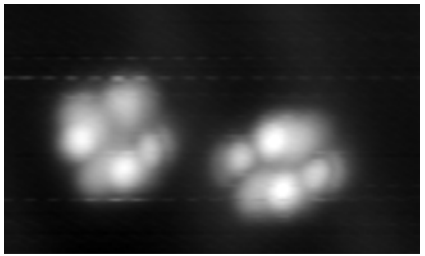
8.6 pA, 0.5 V

Manipulation of dimers by voltage pulses with the STM tip:

(8.7 x 4.3/5.2 nm), 20 pA, 0.25 V-Pulses 0.8V-1.0V, 1s, I=1.2-2nA

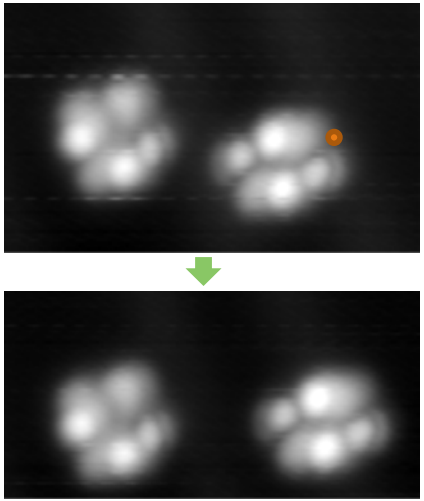


Voltage pulses (at the position of the orange circles) enable dimer movement

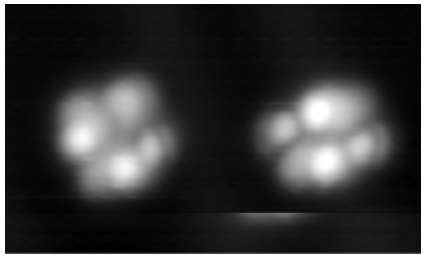


Manipulation of dimers by voltage pulses with the STM tip:

(8.7 x 4.3/5.2 nm), 20 pA, 0.25 V-Pulses 0.8V-1.0V, 1s, I=1.2-2nA

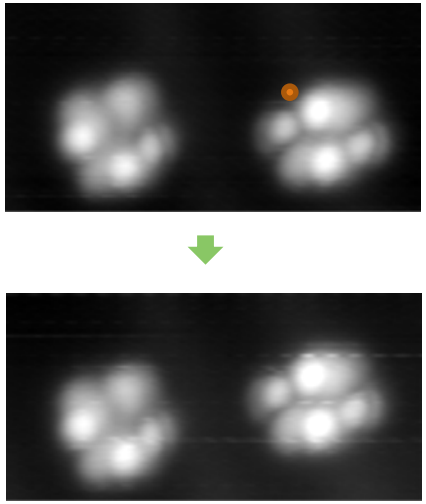


Voltage pulses (at the position of the orange circles) enable dimer movement

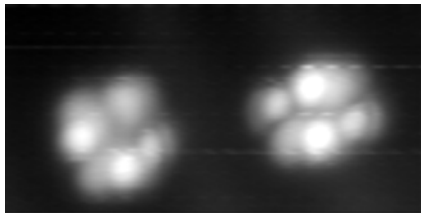


Manipulation of dimers by voltage pulses with the STM tip:

(8.7 x 4.3/5.2 nm), 20 pA, 0.25 V-Pulses 0.8V-1.0V, 1s, I=1.2-2nA

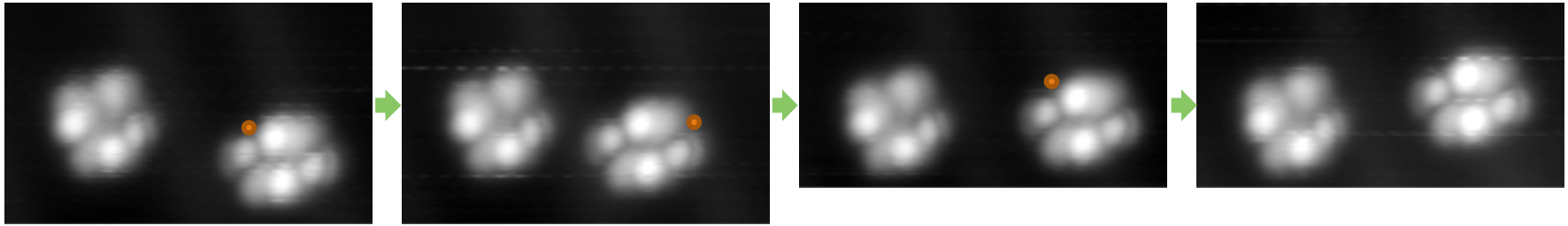


Voltage pulses (at the position of the orange circles) enable dimer movement



Manipulation of dimers by voltage pulses with the STM tip:

(8.7 x 4.3/5.2 nm), 20 pA, 0.25 V-Pulses 0.8V-1.0V, 1s, I=1.2-2nA

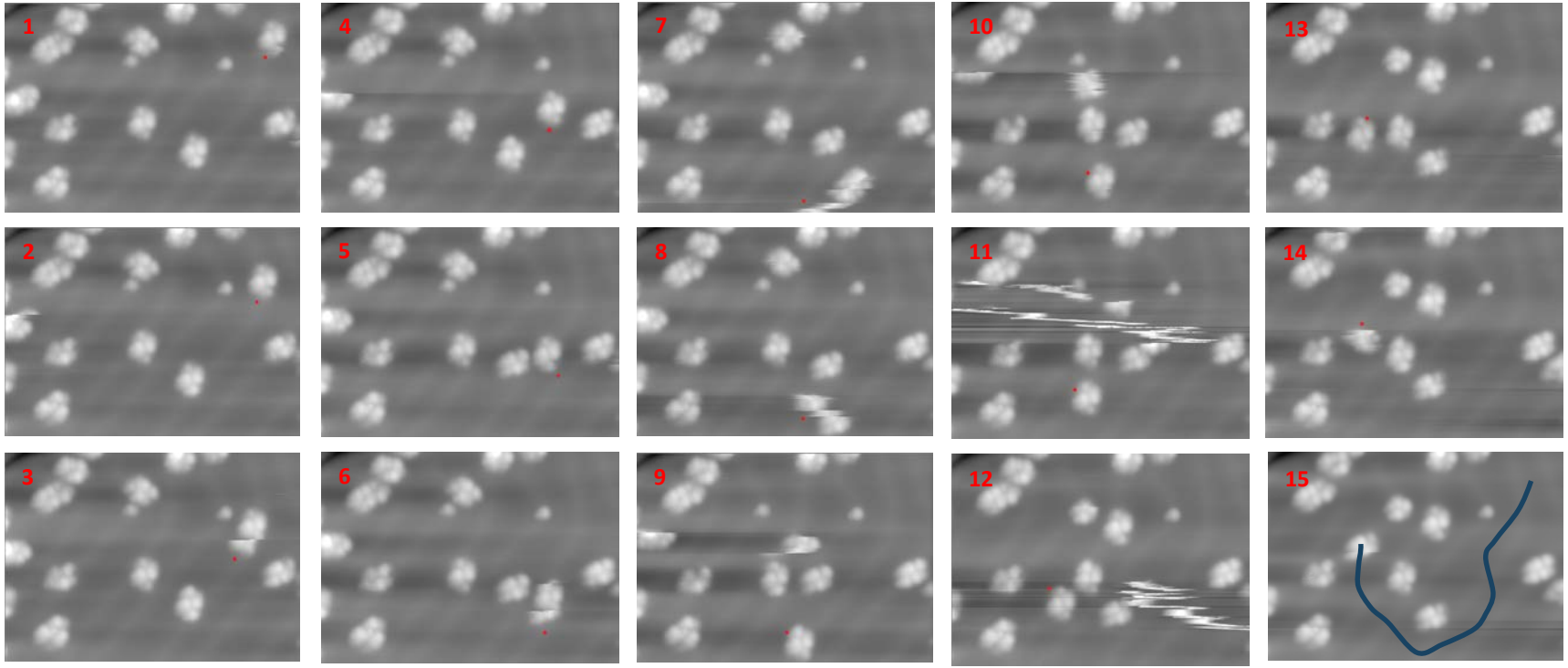


The molecules reproducibly follow the tip-defined direction when pulsing:

-> Positive voltage leads to controlled movement towards the tip, up to > 2nm
-> Negative voltage leads to random movement away from the tip

Further manipulation of dimers at positive voltage:

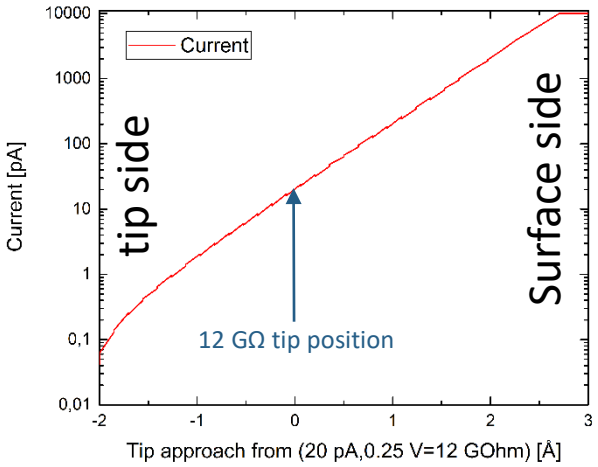
(40x20nm), 12 pA, 0.1 V Pulses 1.2V, 1s, I~2nA

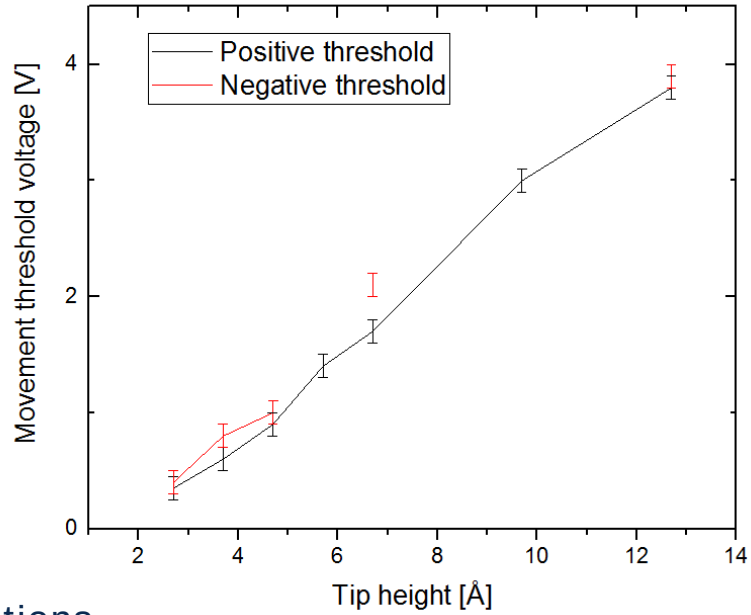


The dimer follows the voltage pulses (red dots) and moves along the blue path marked in the last image

Electric field induced movement

I-Z-Spectroscopy (current curve for tip-approach/retraction needed for height calibration)





- From I-Z curve: ~2.7 Å tip height at imaging conditions
- The linear dependence of the threshold voltage vs. tip height indicates an electric field induced movement
- Dimers are still moved at >10 Å tip height, practically without tunneling current (see I-Z-spectroscopy)

Summary

- ➔ Very mobile, small molecular islands on the surface
- ➔ Most common is a dimer:
  - ➔ Single molecule isolation is not possible
  - ➔ Laterally easily movable (lateral manipulation)
  - ➔ Pulsing leads to field-effect-induced movement:
    - ➔ Positive bias: towards tip
    - ➔ Negative bias: away from the tip