Development of Novel Scintillation Detectors

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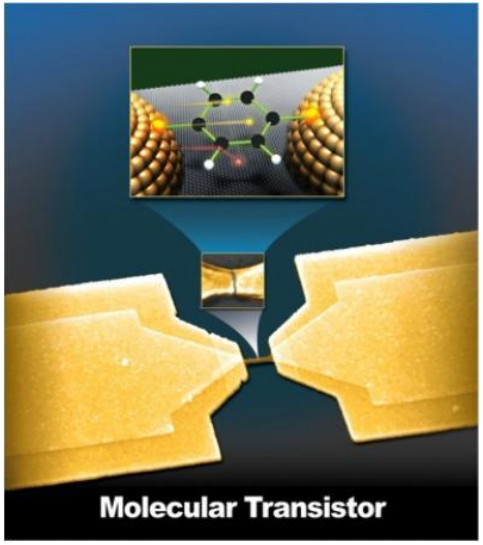
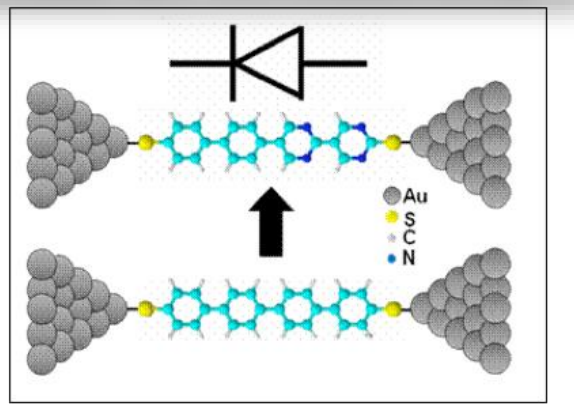
Single organic molecular-electronic applications



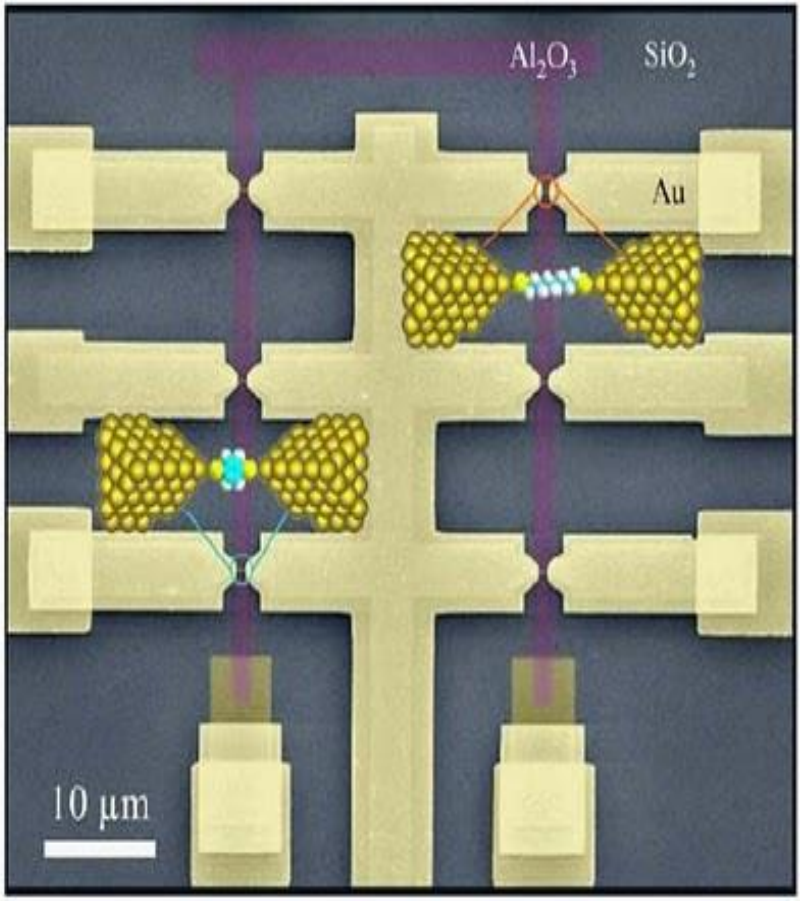
molecular transistors

J. McCormack, MST. www.virtualsecrets.com



Molecular Nanocomputing Devices

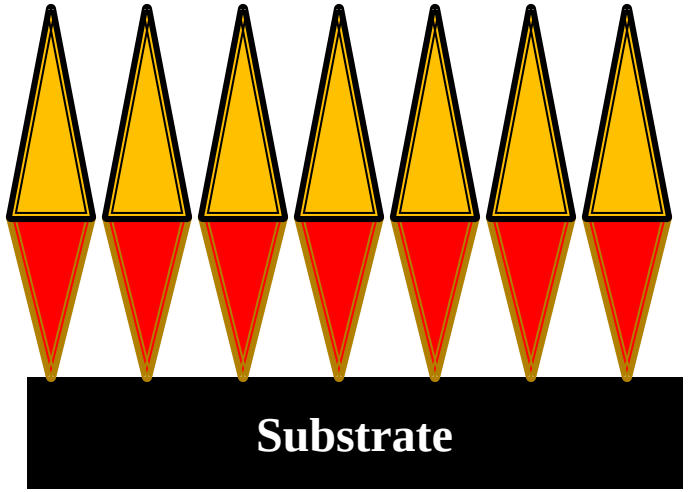
N.Tao, L.Yu and I.Oleynik, University of South Florida.

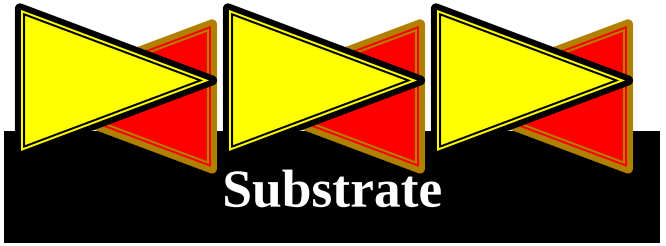


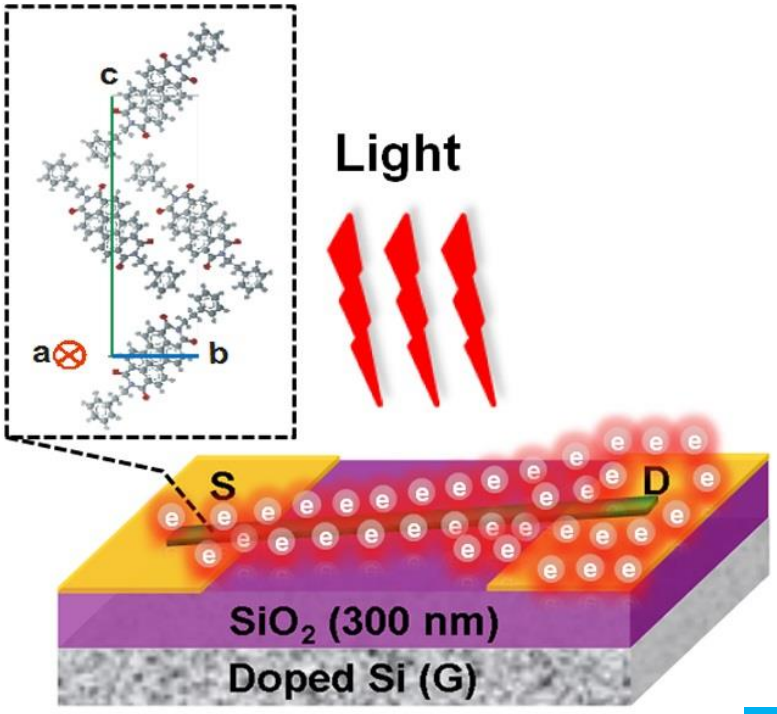
Control the single molecule orientation and the interface to substrate is required.

J. McCormack, MST. www.virtualsecrets.com

Examples of adsorption orientation

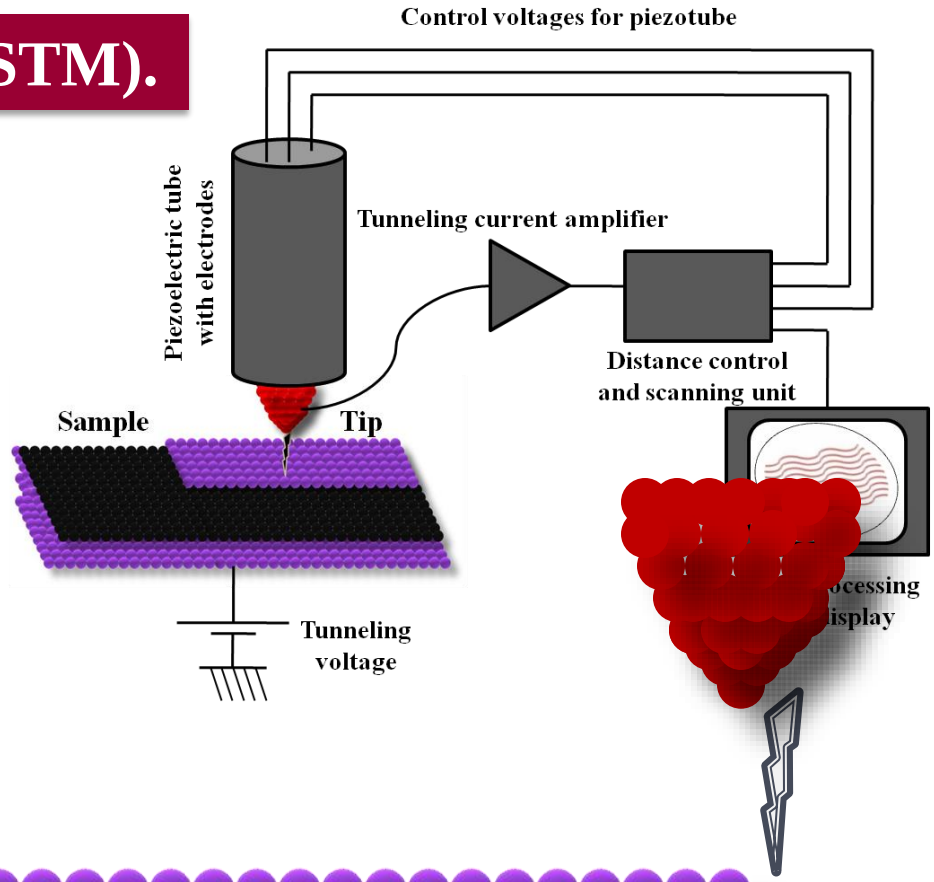


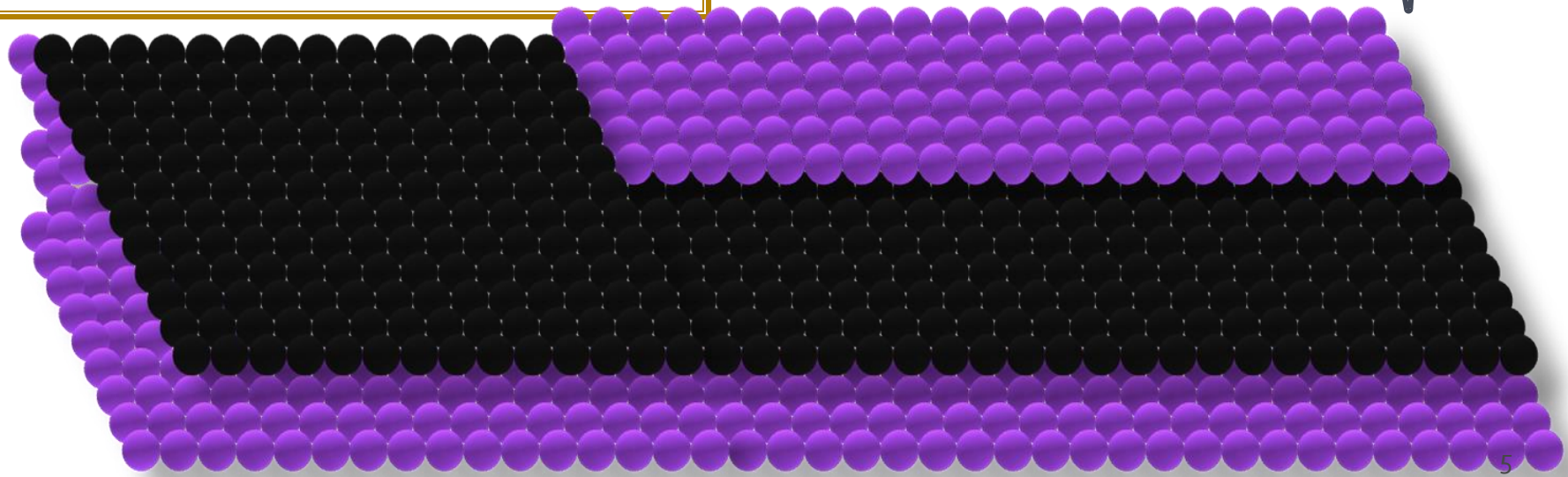




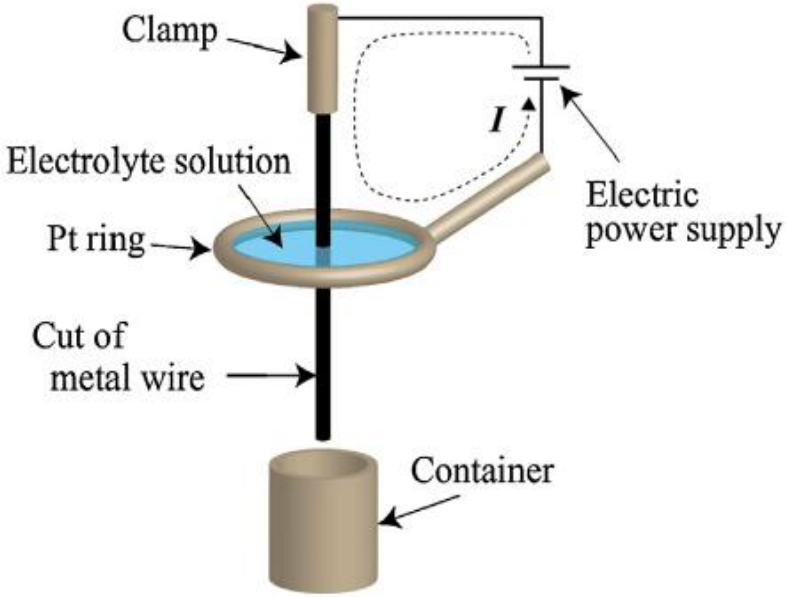
Scanning tunneling microscopy (STM).

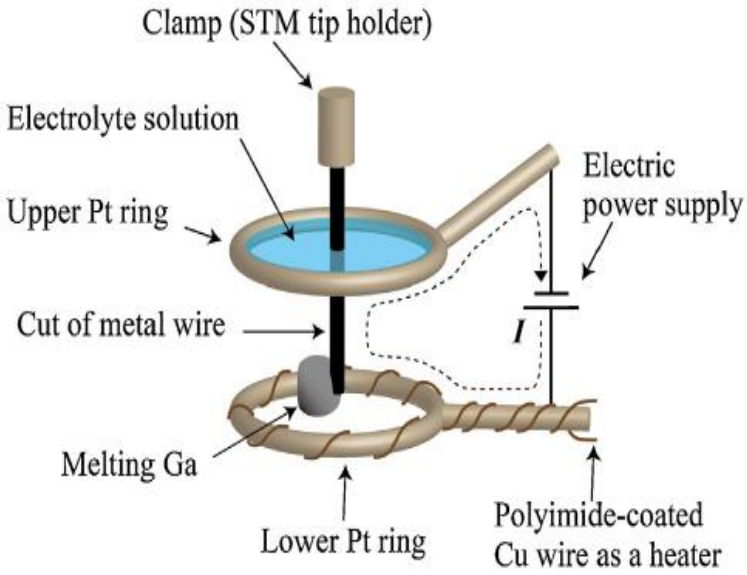
The basic schematic of STM is shown in this figure. A sharp metal tip is brought so close to a sample surface that electrons can tunnel quantum mechanically through a vacuum barrier separating the tip and the sample. The probe tip, usually made of W or Pt-Ir alloy, is attached to a piezo drive, which consists of three mutually perpendicular piezoelectric transducers: x, y, and z piezos.

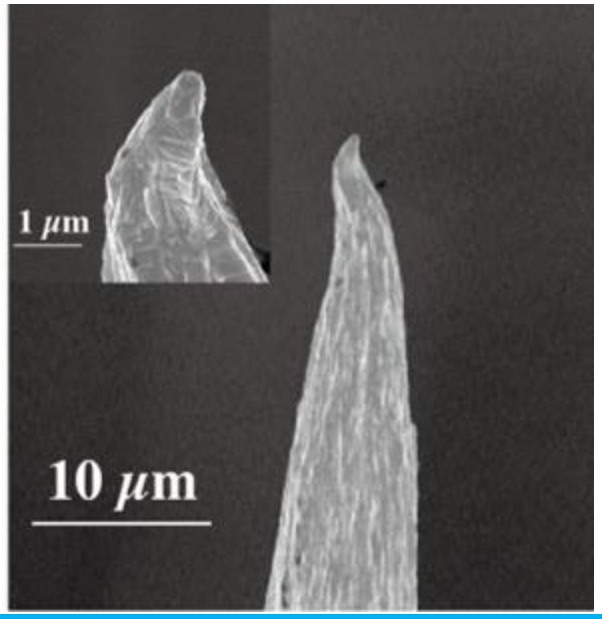


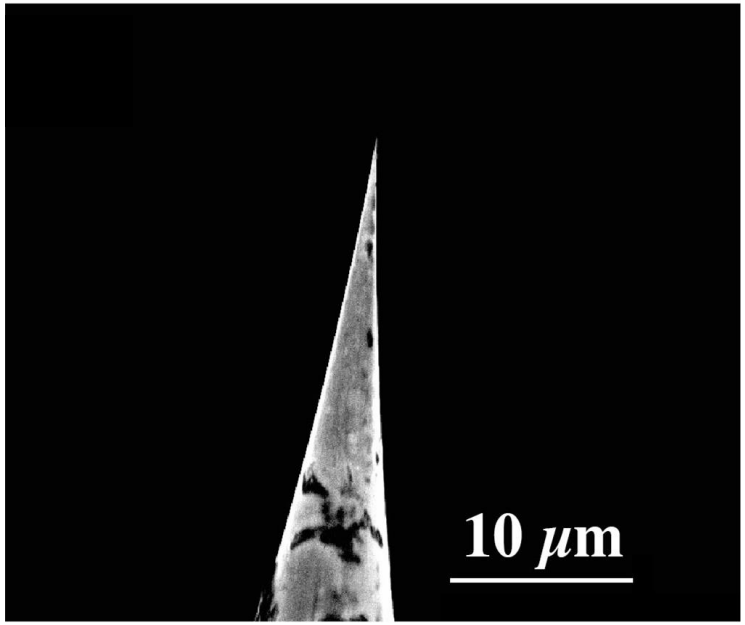


Electrochemical etching of W tip





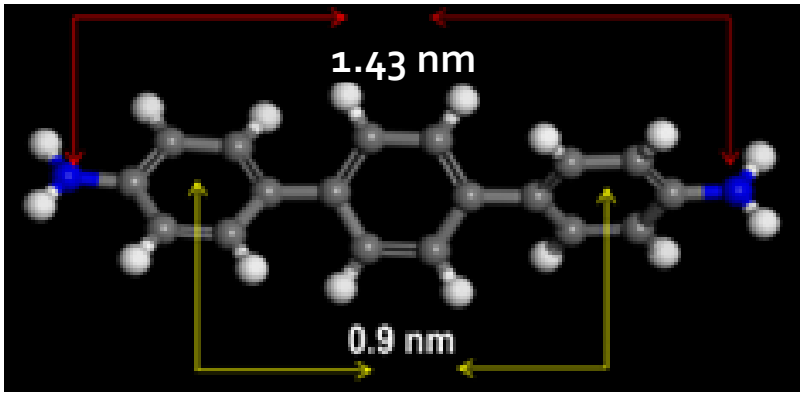




T. Nishimura, **A. M. A. Hassan** and M. Tomitori, Applied Surface Science 284 (2013)

4,4’’-diamino-*p*-terphenyl (DAT)

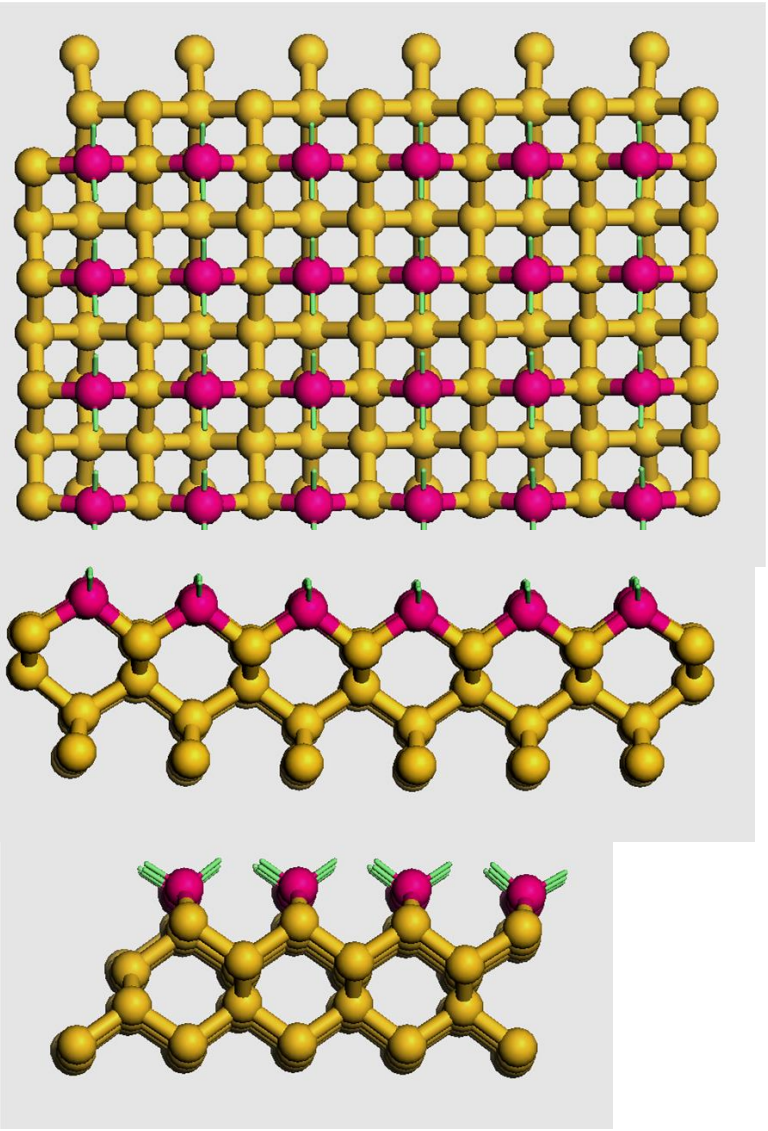
- Organic composite scintillators such as ***p*-terphenyl** can be compared with the organic liquid scintillators, composites are solids and **less flammable; flash point for *p*-terphenyl is 207 °C and for stilbene over than 112 °C**. Composite scintillators are sensitive not only to fast neutrons, but also to ɣ-rays; however, **the signals** from these events **can be well separated**. The composite scintillators can also **be obtained in larger diameter than organic single crystals**, but they must be thin enough to achieve the performance which is the key of issue.

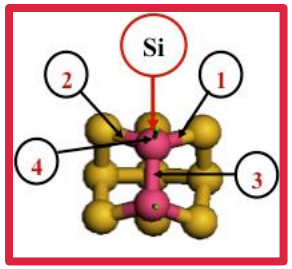


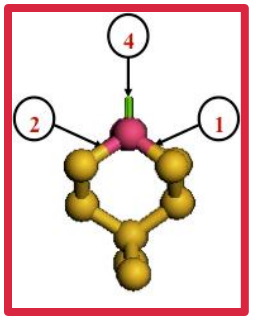
- DAT has been used for a monomer of conjugated polymer, polyazomethine, which was employed for electroluminescence (EL) devices prepared by vapour deposition polymerization. Fabrication of one monolayer and controlling the interface between organic molecules and substrate improve the performance of the molecular devices by changing its electronic properties, so that alignment and fabrication of one monolayer of DAT on Si surface is the final target of our study.

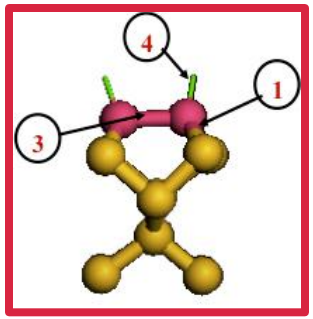
Present work

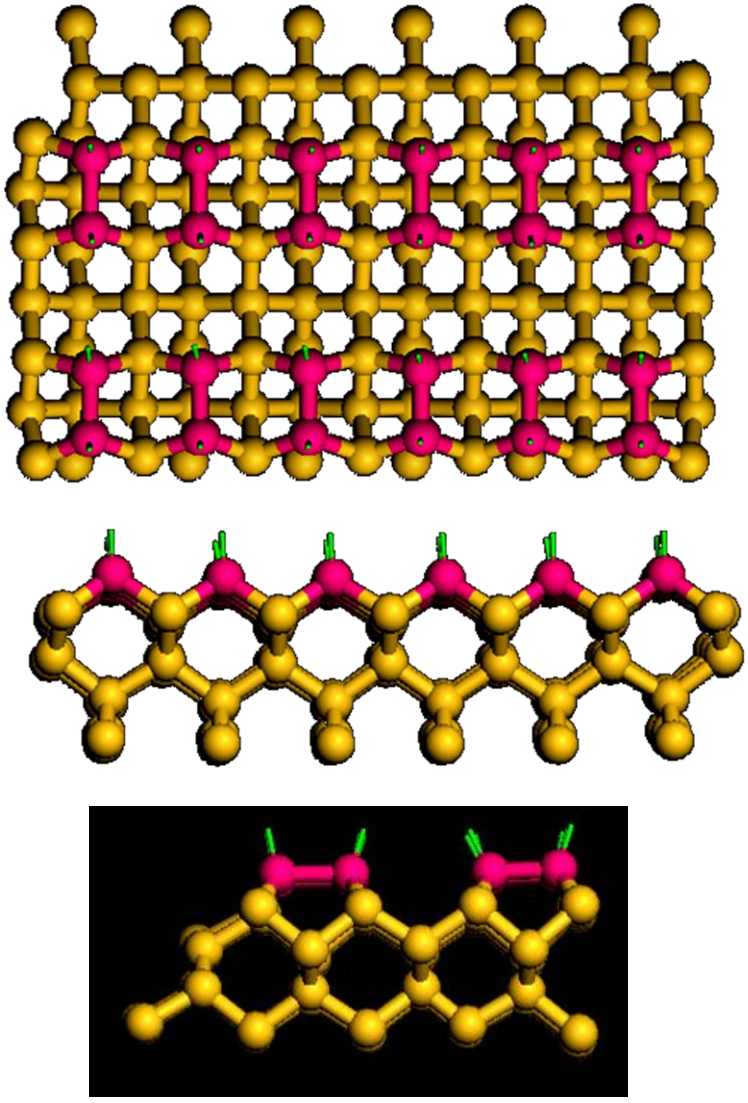
Si(001)











(1x1)

(2x1)

Previous work of DAT

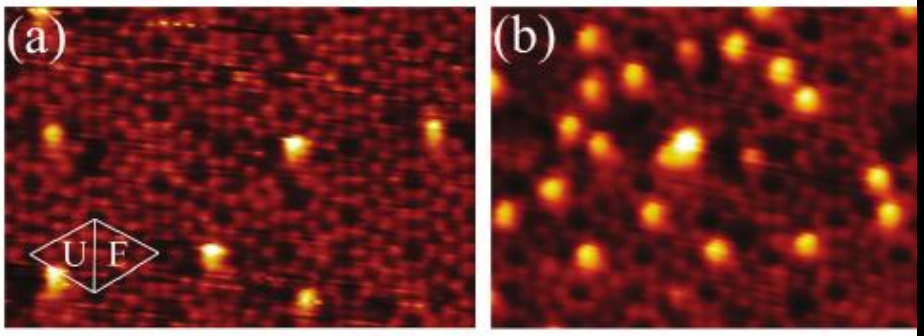
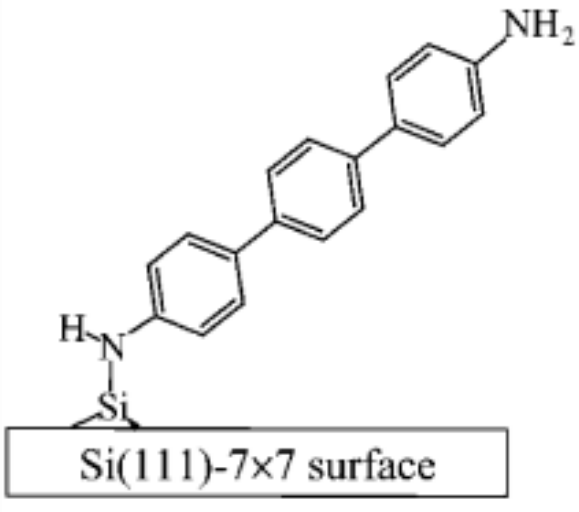
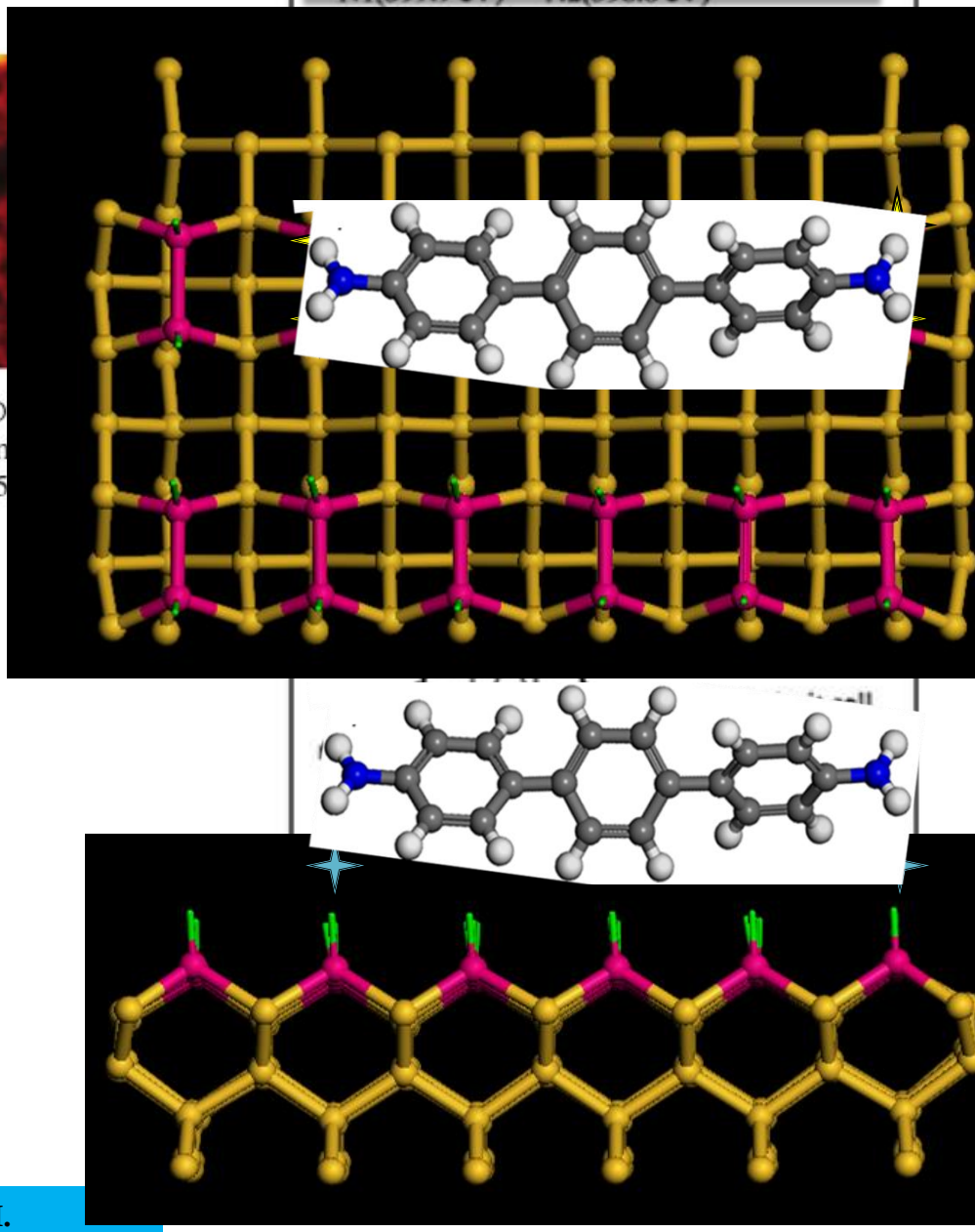


Figure 2. STM images of Si(111)-7 × 7 surfaces covered with D
at (a) 0.2 molecule/unit cell and (b) 0.8 molecule/unit cell. Scann
area: about 18 nm ×12 nm. STM imaging conditions: V_{tip}= −1.5
I_{tunnel}= 0.05 nA.

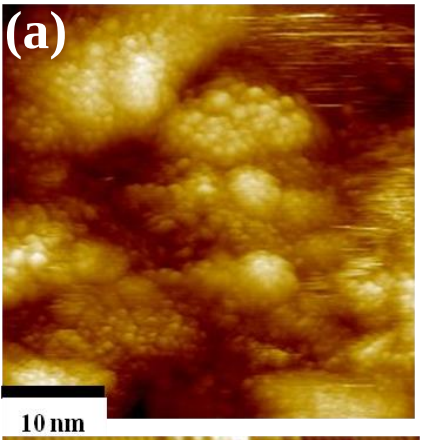


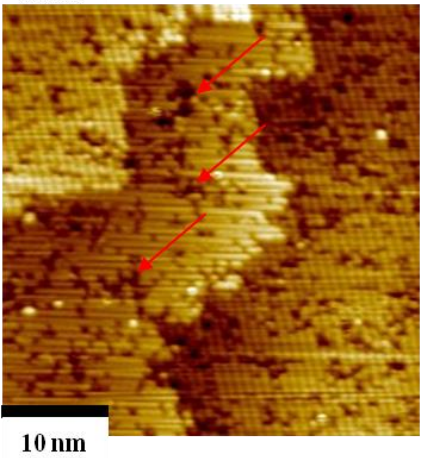
T. Nishimura, A. Itabashi, A Sasahara, H. Murata, T. Arai, and M. Tomitori, J. Phys. Chem. C 114, 11109 (2010).

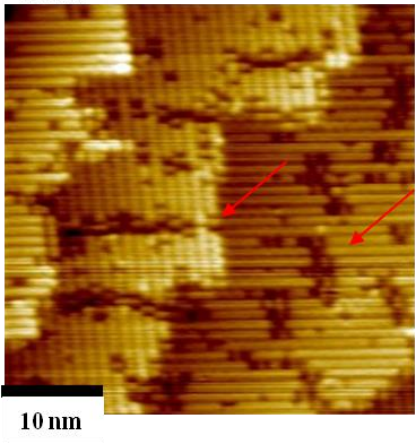
Present work

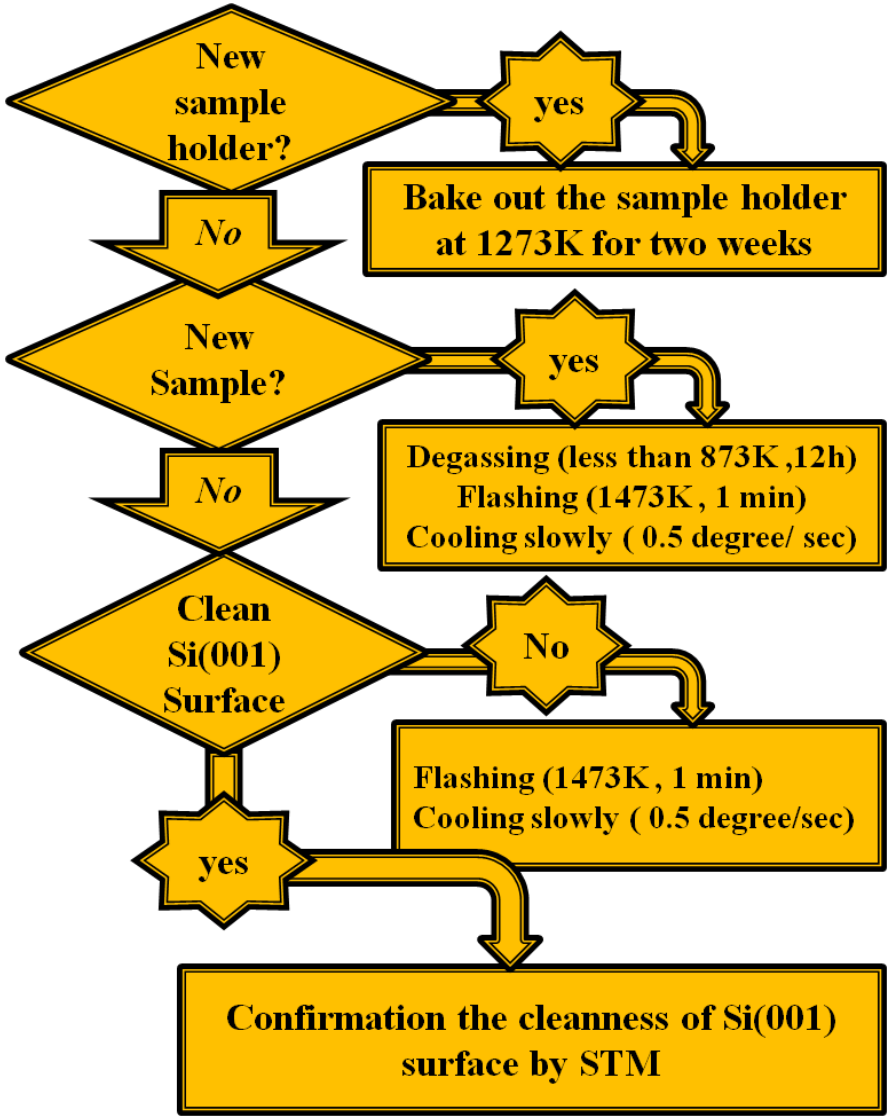


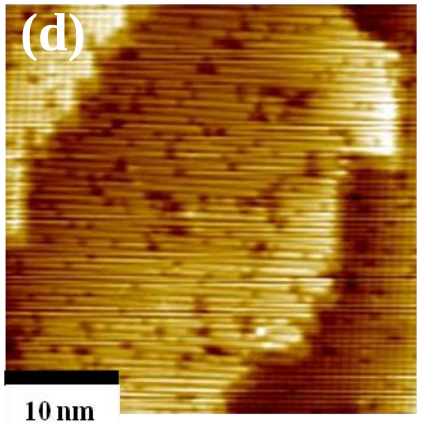
Fabrication of clean Si(001) surface

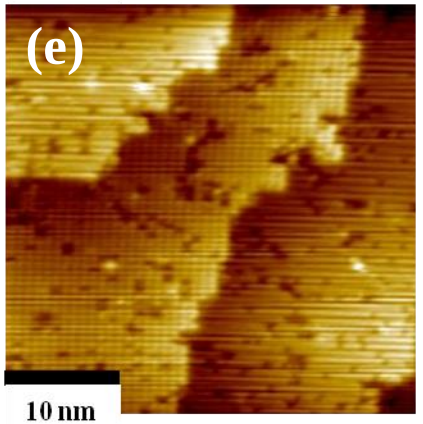


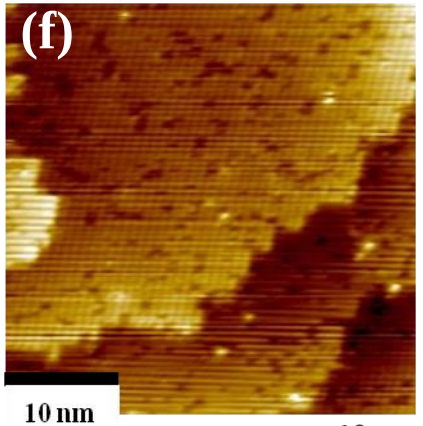




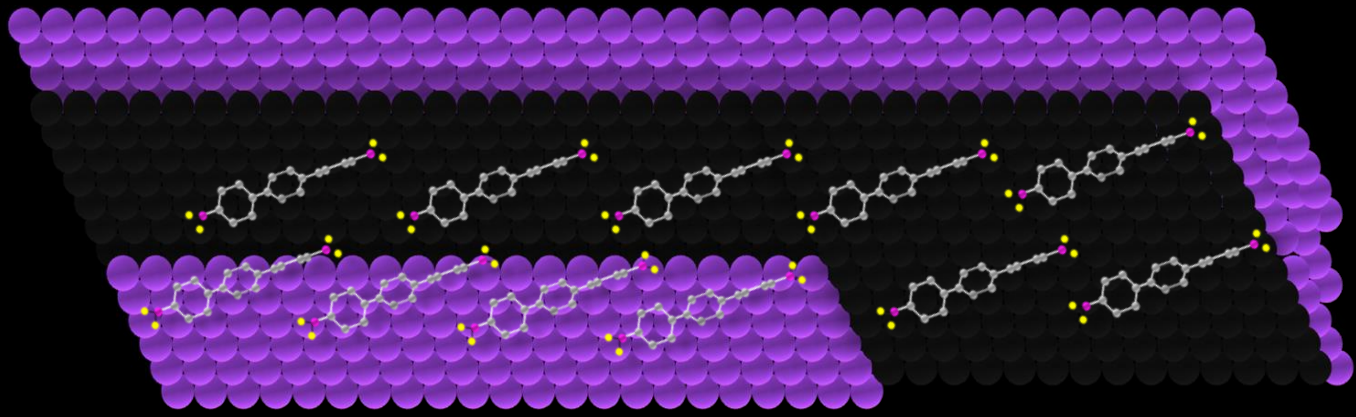


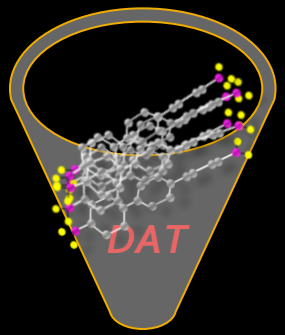




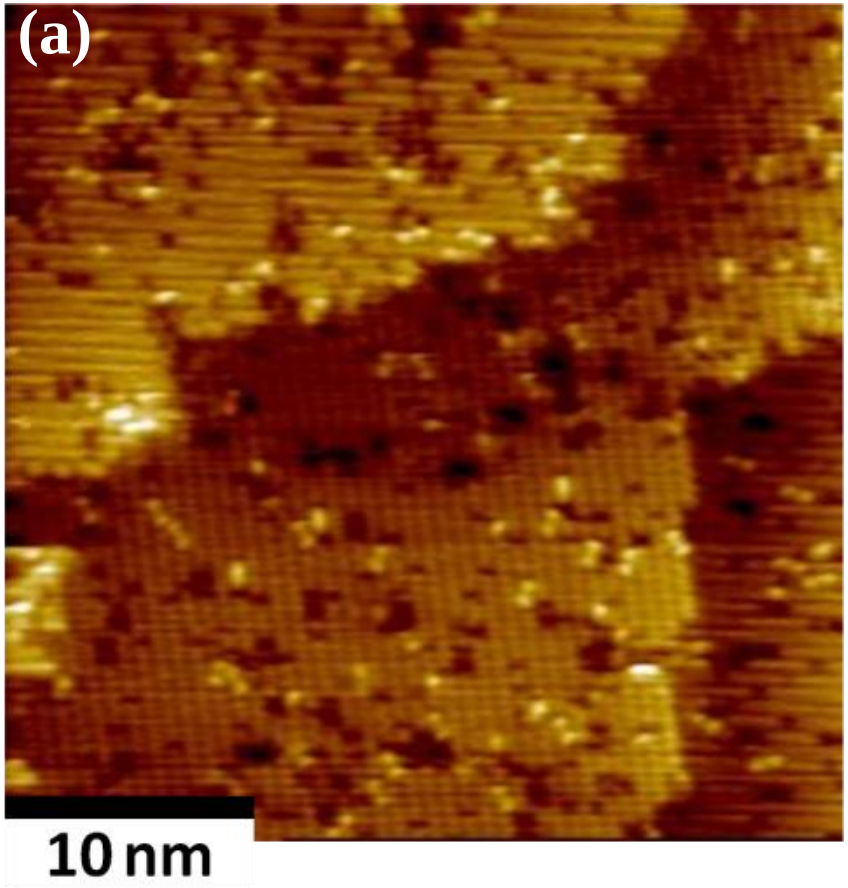


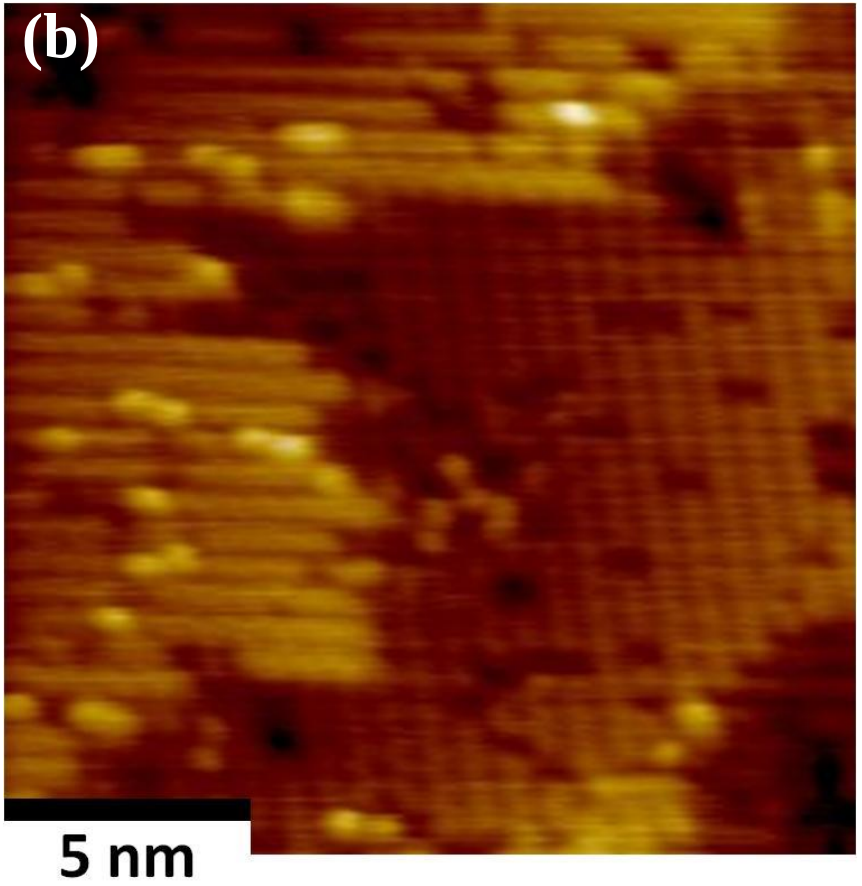
Vapor deposition of DAT molecules on Si(001) surface.





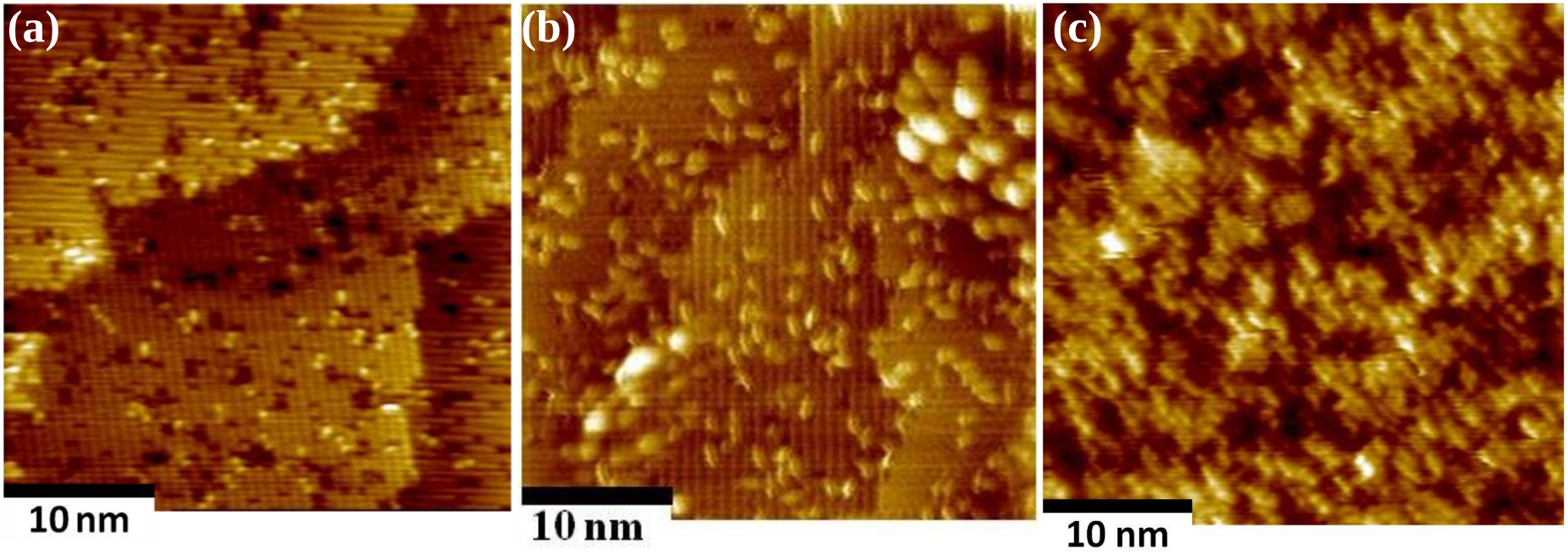
STM observations of DAT deposited on Si(001) at low coverages



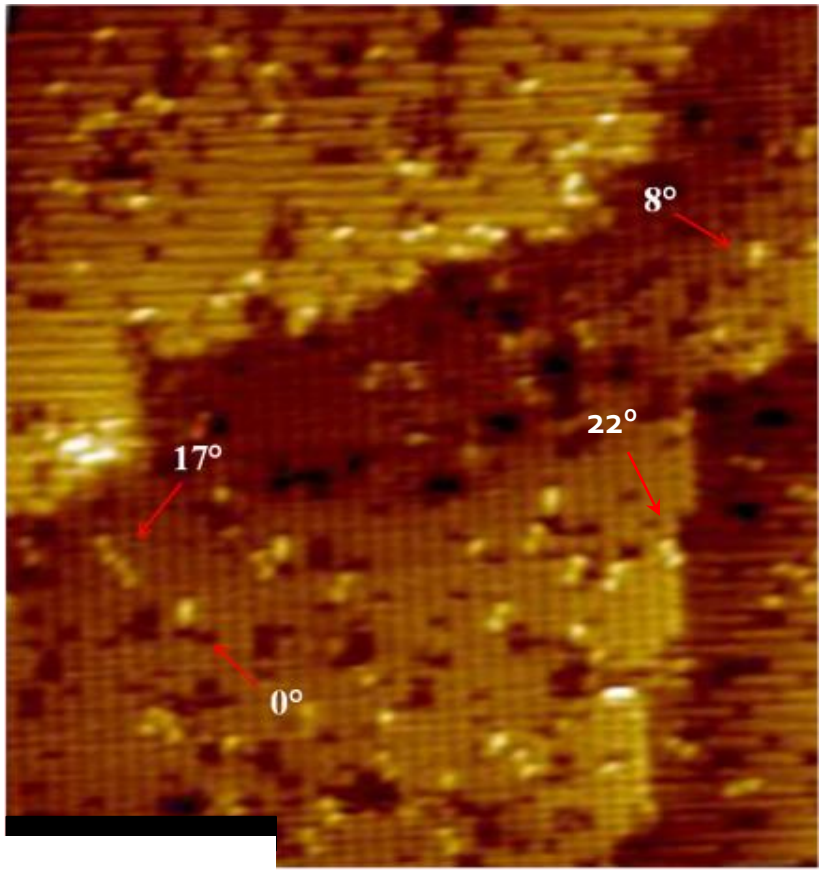


STM images taken at I_{tunnel} = 0.1 nA and V_{tip} = +1.5 V. of DAT deposited at 0.04 molecule/nm^2 coverage on Si(001)-(2×1) at RT.

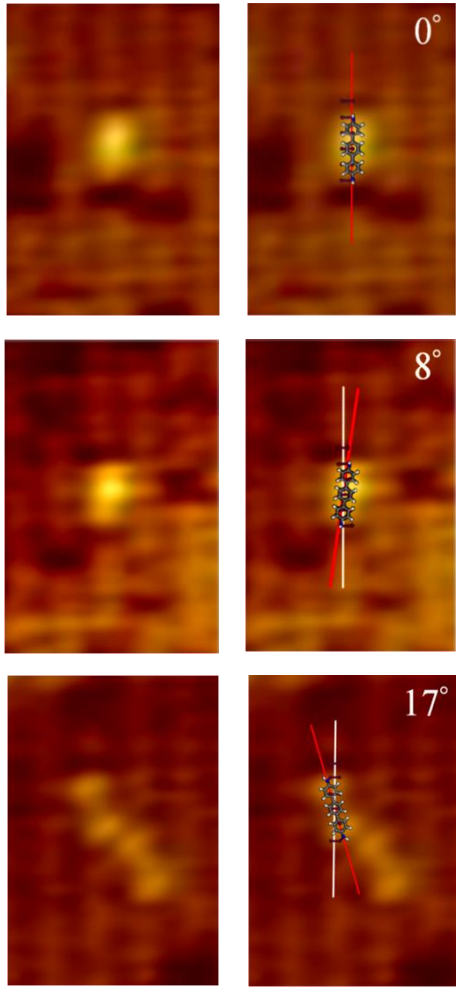
STM observations of DAT deposited on Si(001)

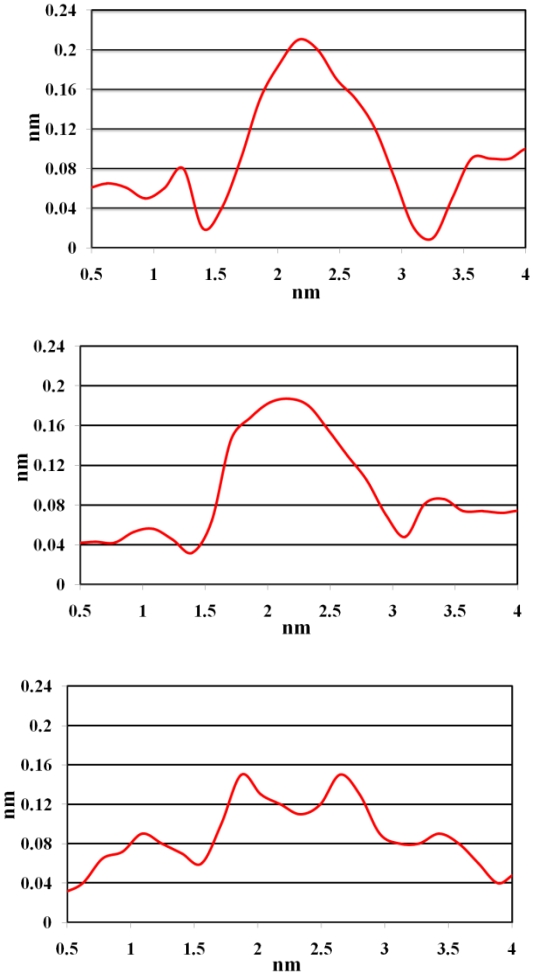


STM images taken at I_{tunnel} = 0.1 nA and V_{tip} = +1.5 V. of DAT deposited on Si(001)-(2×1) at RT.



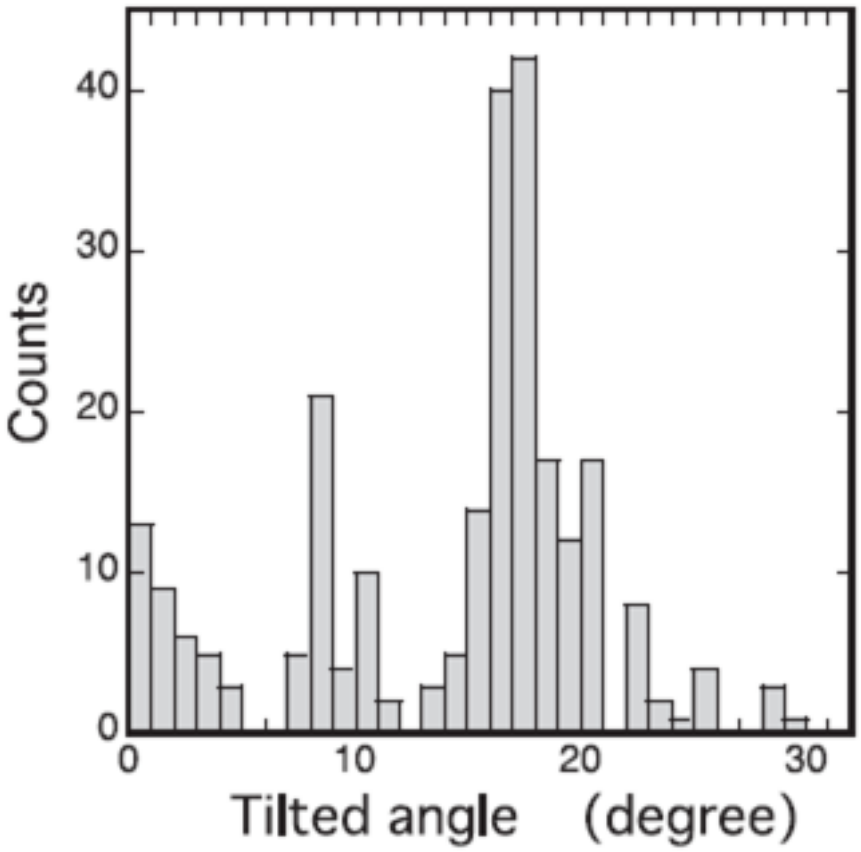
10 nm





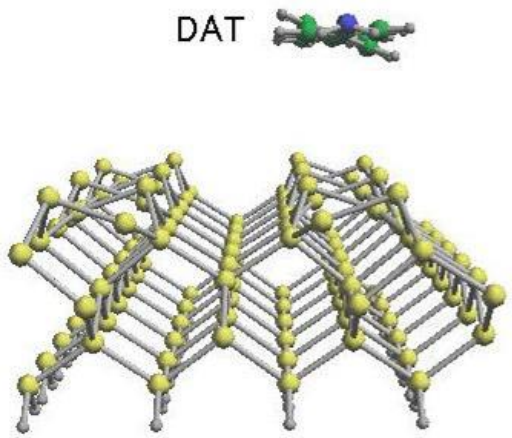
0°	0.14	0.09-0.18
8°	0.1	0.06-0.13
17°	0.08	0.06-0.13

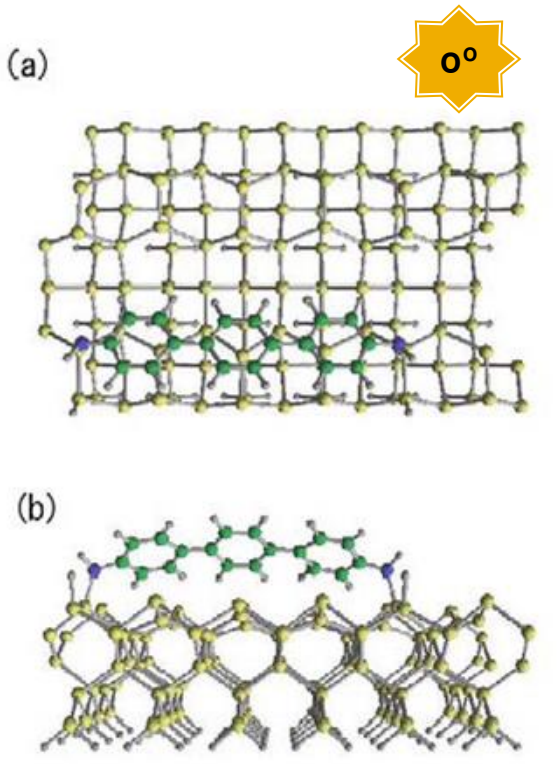
Statistical evaluations of the adsorption configurations of DAT on Si(001).

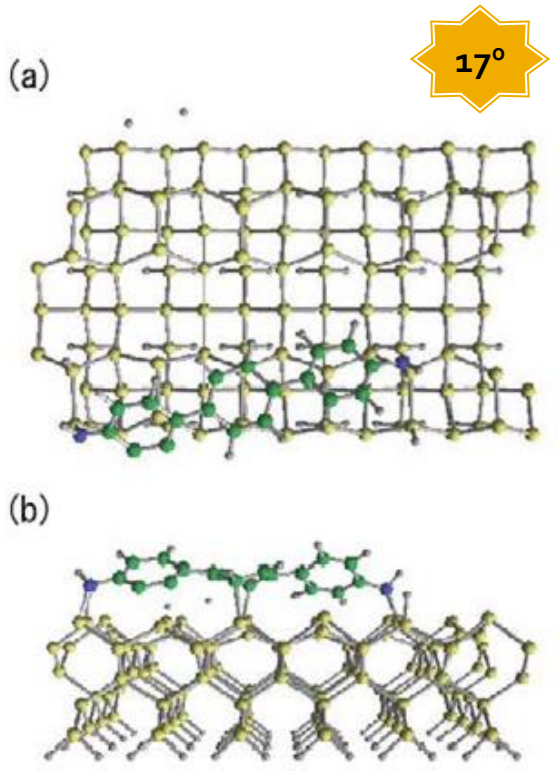


Histogram of the tilted angle of a DAT molecule with respect to the direction of dimer row of Si(001)-(2×1), which was deposited at room temperature.

Density Functional Theory (DFT)





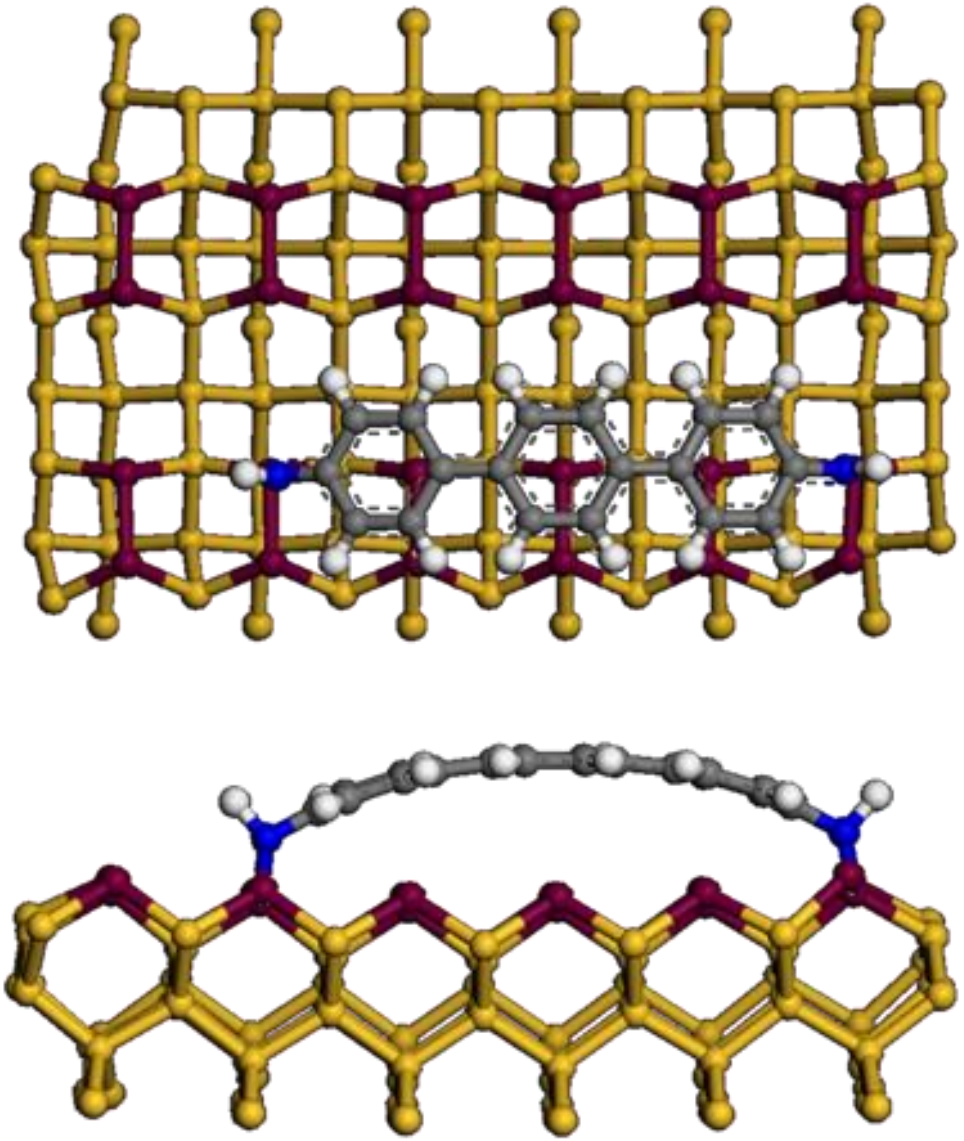


Total energy : -1.66 eV

Total energy : -2.34 eV

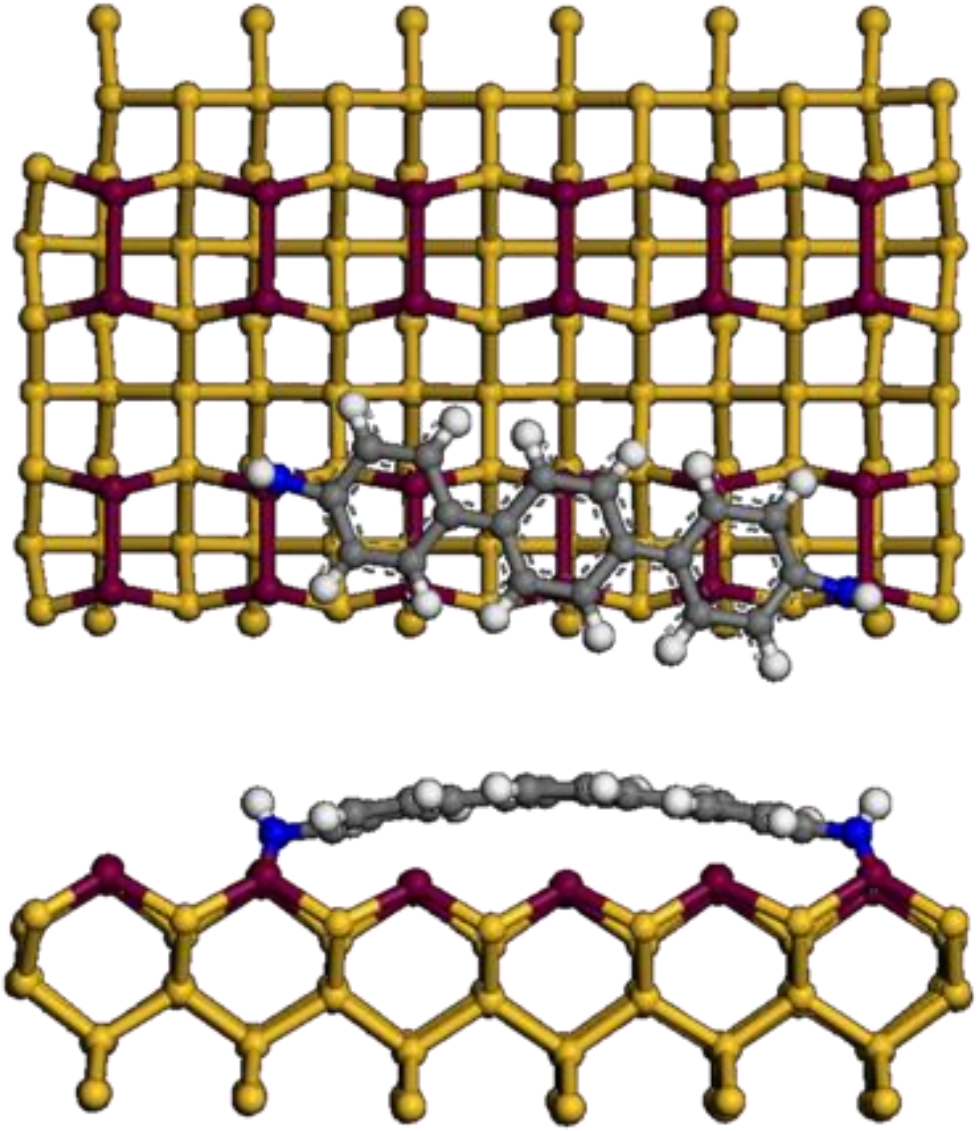
M.Oda, Phys. Status Solidi C, 1– 3 (2012)

0°



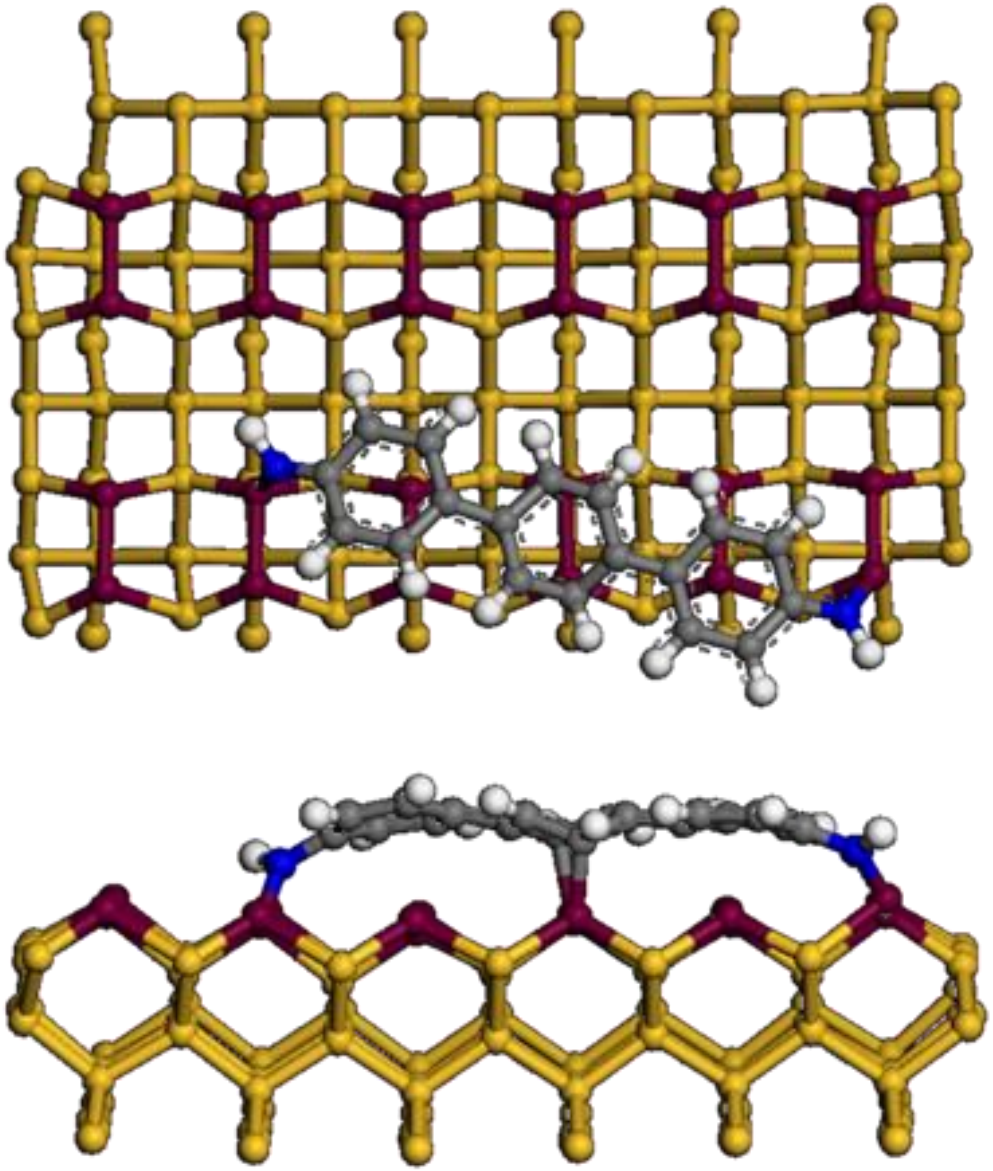
Top and side view of models for chemical bonding configurations of a DAT on the Si(001)-(2×1) with tilted angle of 0°

8°

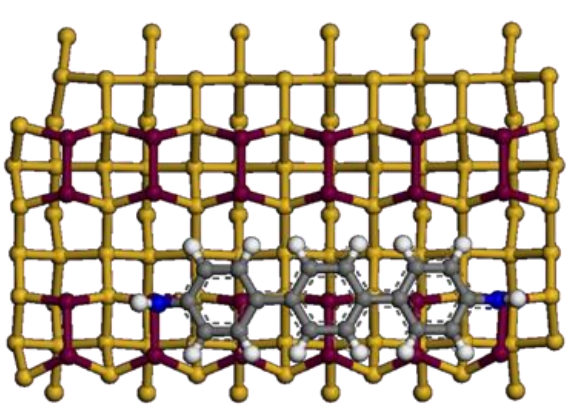


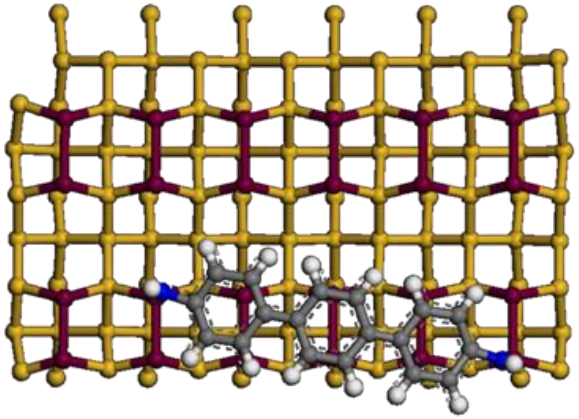
Top and side view of models for chemical bonding configurations of a DAT on the Si(001)-(2×1) with tilted angle of 8°

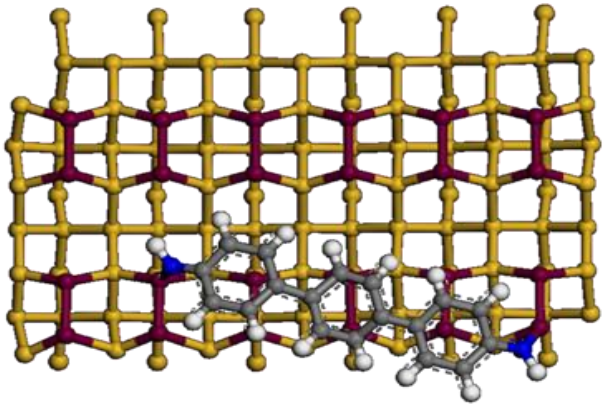
17°

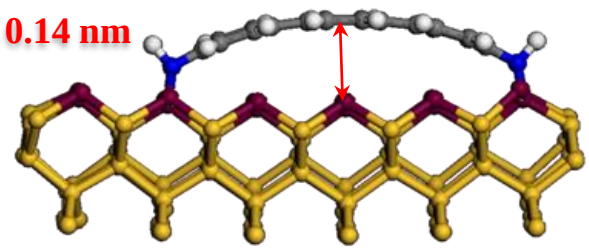


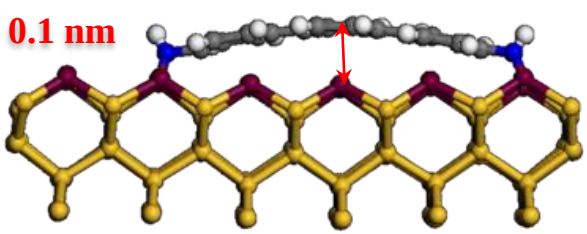
Top and side view of models for chemical bonding configurations of a DAT on the Si(001)-(2×1) with tilted angle of 17°

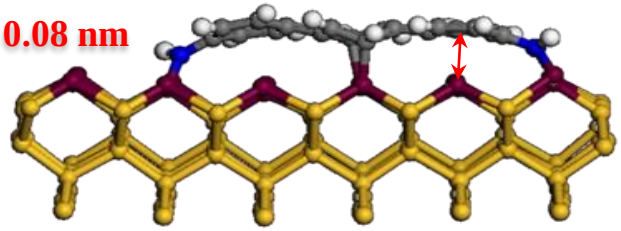


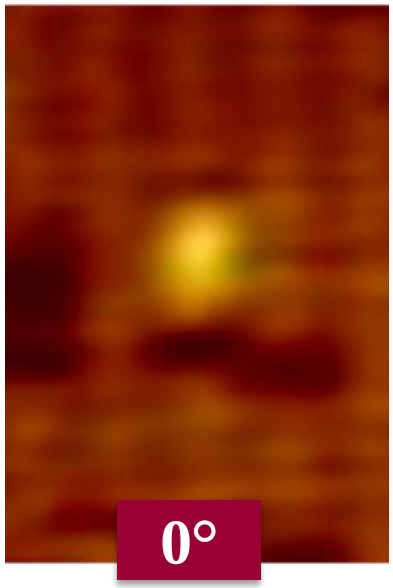


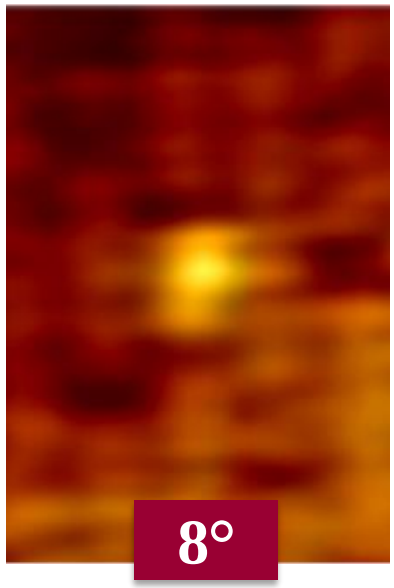


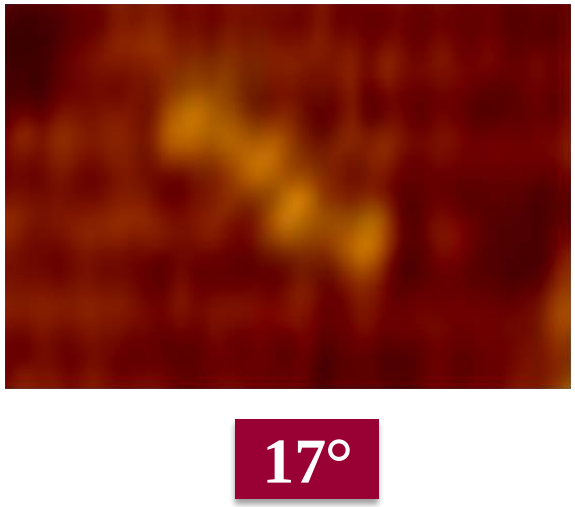

0.14 nm


0.1 nm

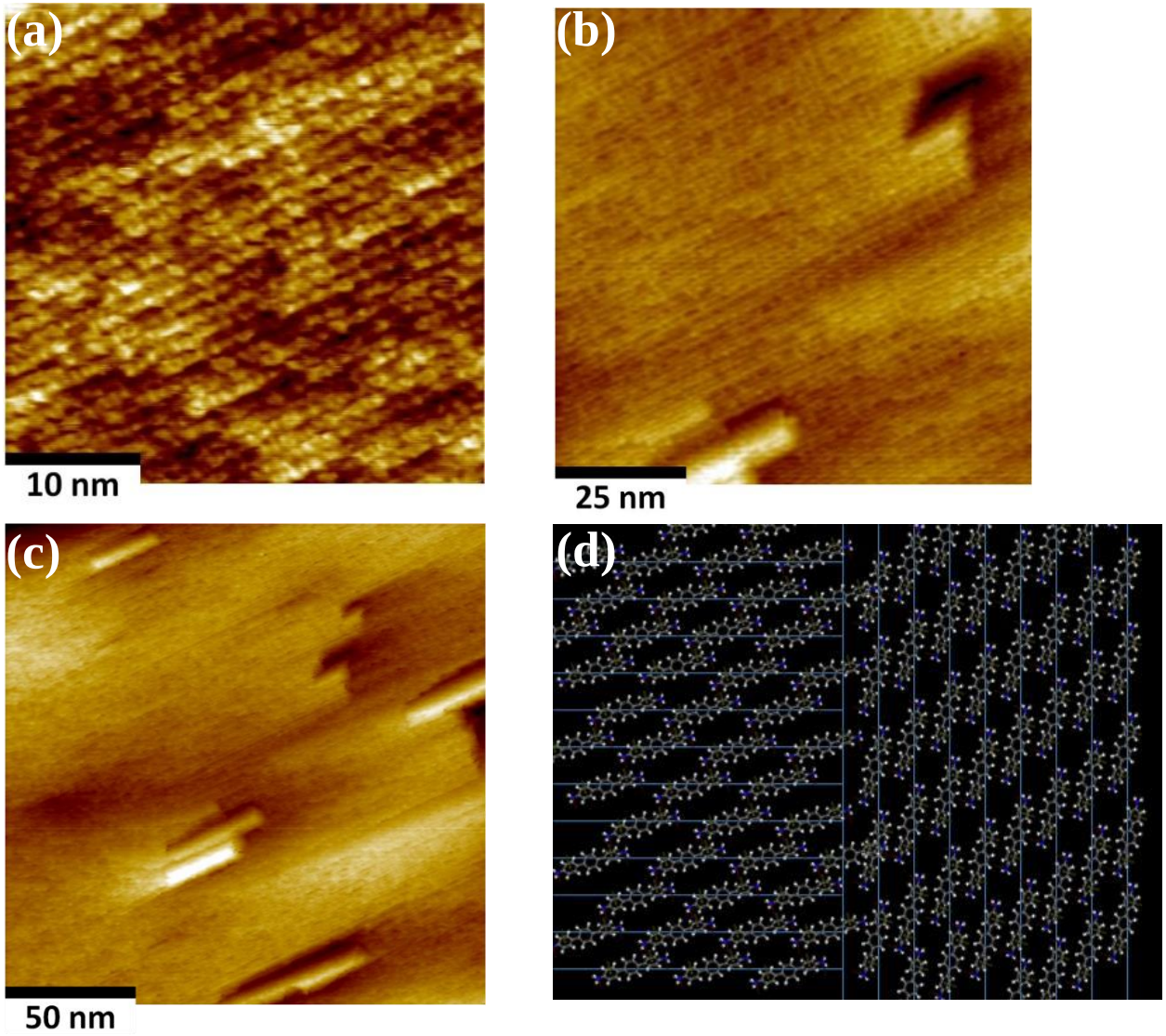

0.08 nm


0°


8°


17°

Fabrication of ultrathin film of DAT on Si(001)



STM images of DAT molecules on the Si(001) after annealing at 523 K for 1 min, and (d) expecting model.

Conclusion

1. The adsorption of DAT on a Si(001)-2×1 surface was observed by STM.
2. There are three stable structures at tilted angles of 0°, 8° and 17° relative to Si dimer rows.
3. The most frequent tilted angle of DAT molecules was 17°.
4. Our Experimental results in agree with DFT calculations.

Thanks