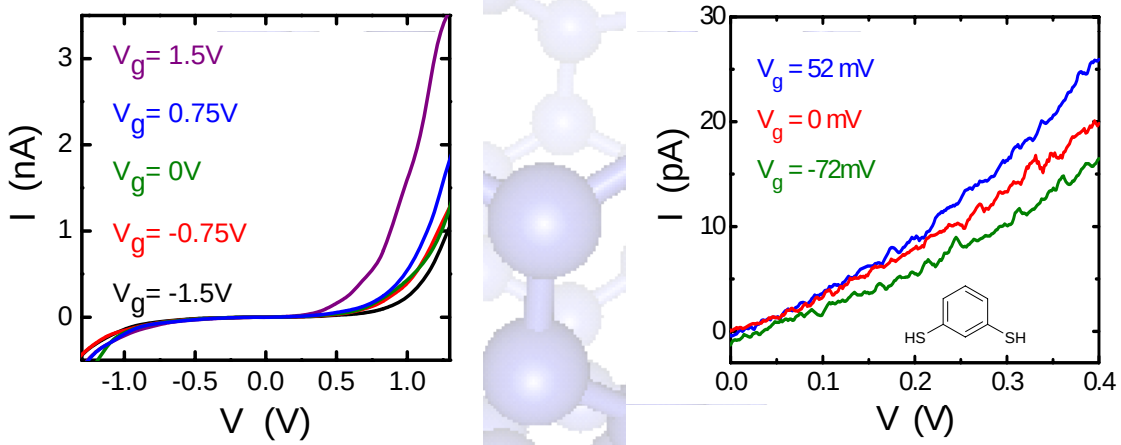
Small gate effect observed in 1,3-benzene dithiol



Gain ~ 0.3

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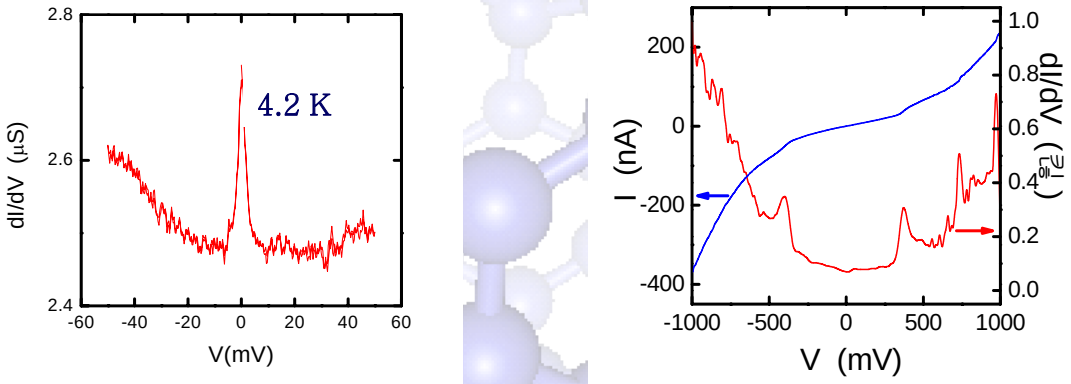
Electrical transport measured in devices with in 1,4-phenylenediisocyanide



No gate effect had observed

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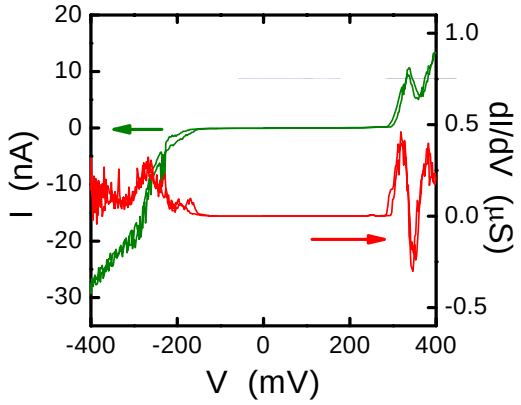
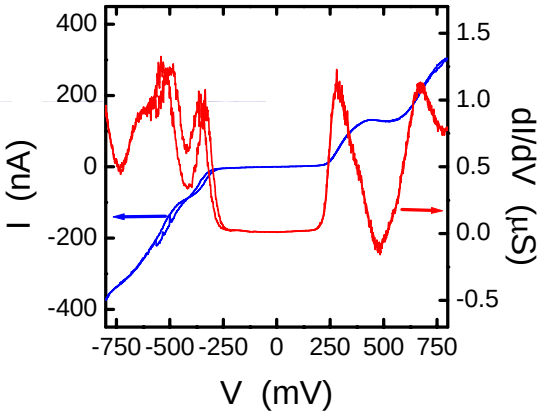
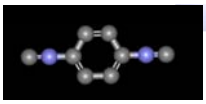
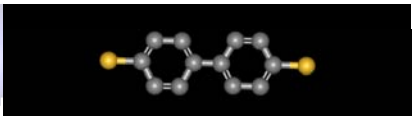
No gate effect, conductunce tends to increase as the number of benzene ring increases









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Conclusion from sandwitch junction

- The yield of the devices was very low.
- A small gate effect observed only in two samples out of ~1000 devices, and this is reasonable since,
  1. Due to the geometry of the device, only ~ 5% of the contacted molecules can be effectively gated.
  2. channel length (~ 1nm) is much shorter than the gate dielectric (~ native AlOx)
- There is not much prospect for developing SAMFET transistors based on short molecules.
- Negative differential conductance peaks has been observed for some of the samples

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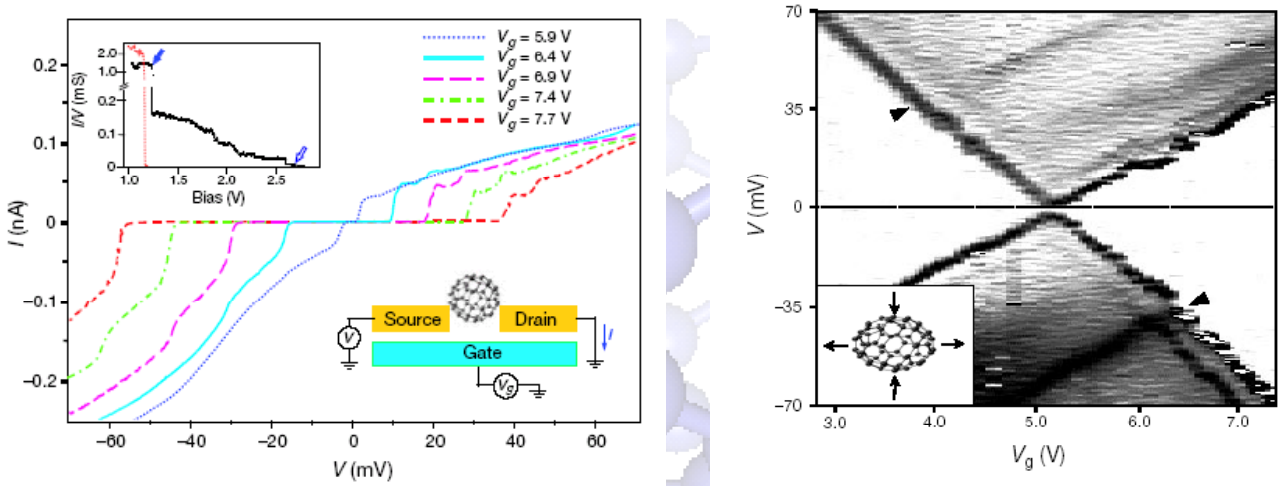
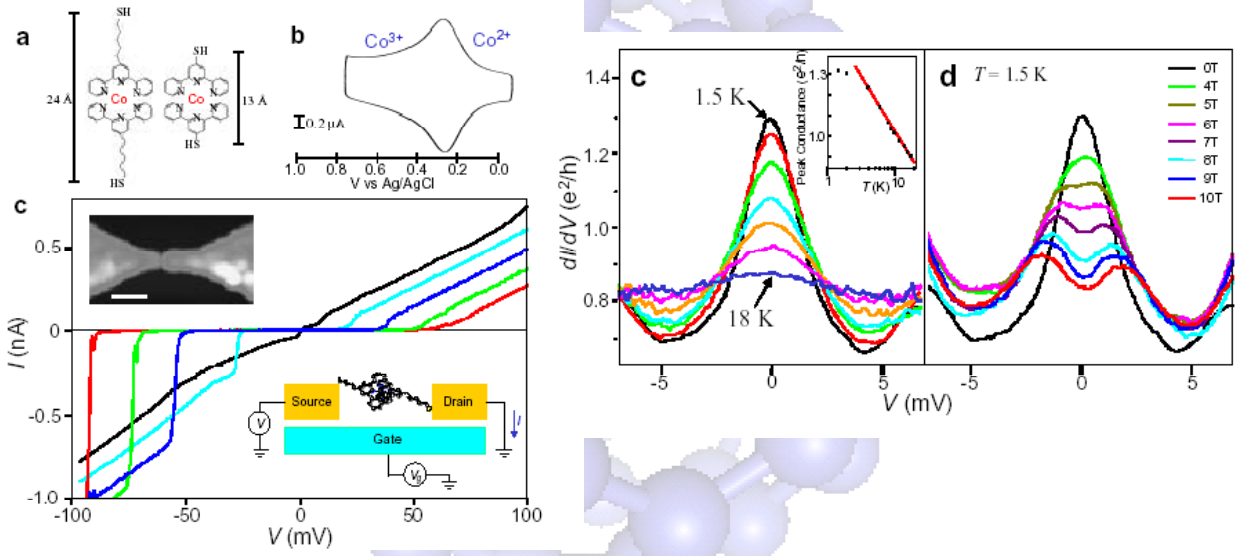
Planar gap electrode

Electromigration

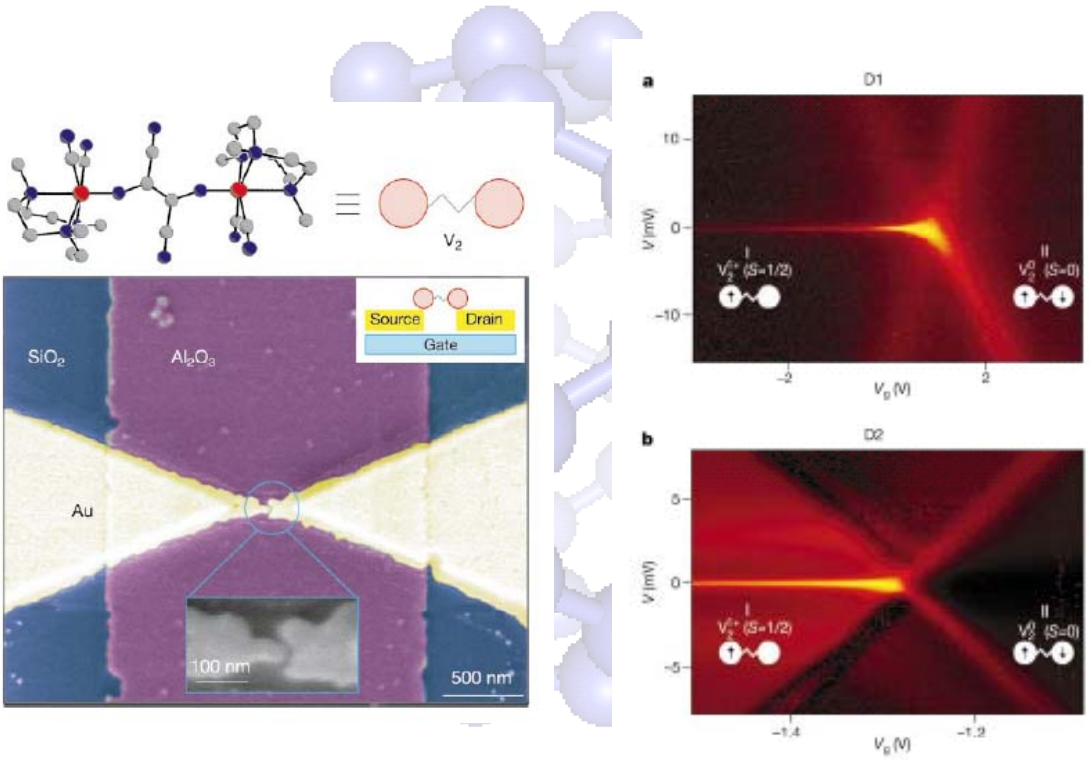


Electrical transport in C60 molecules-Park et al., 2000

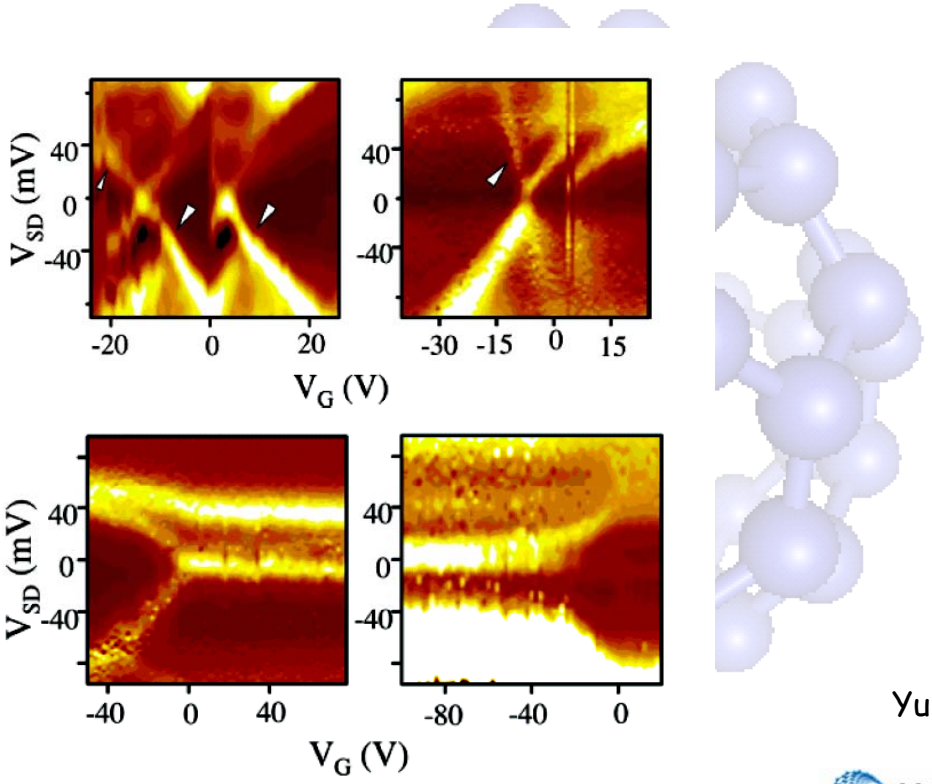
Single atom transistor-Park et al., 2002



Single molecule transistor-Liang et al., 2002

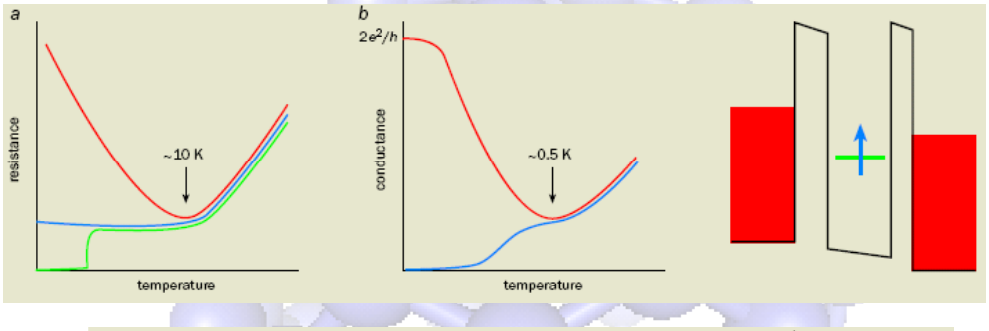


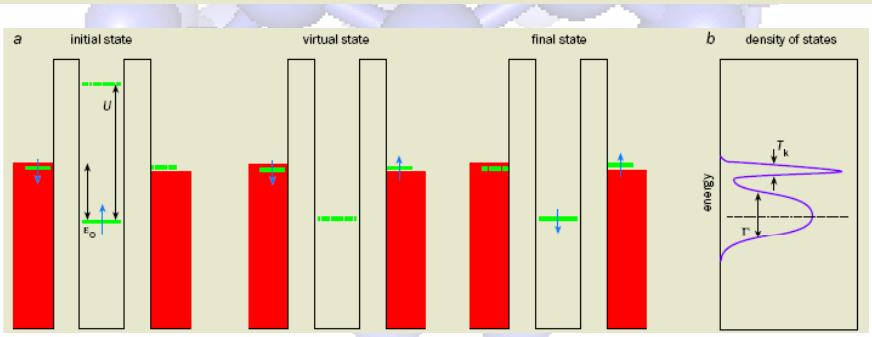
Kondo effect in C60 molecules



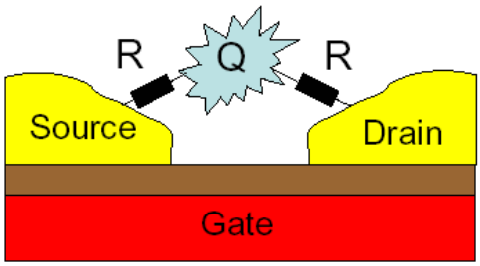
Yu et al., 2004

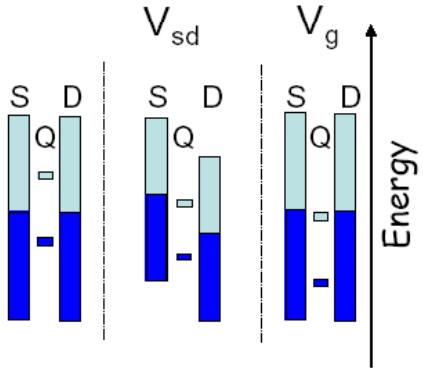
Kondo effect in a quantum dot





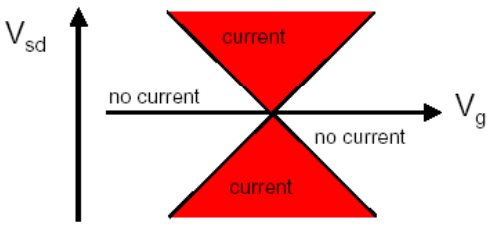
L. Kowenhoven et al.,





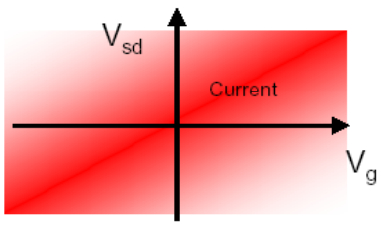
$R \approx G\Omega$, $Q = ne$

Sequential electron transfer

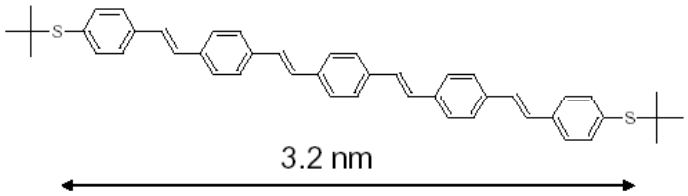


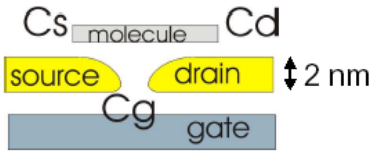
$R \approx k\Omega$, $Q \approx 0$

Tunneling



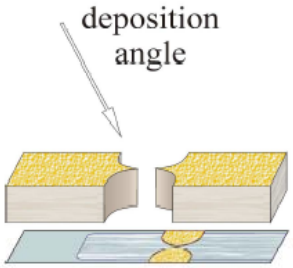
Fabrication of the SET

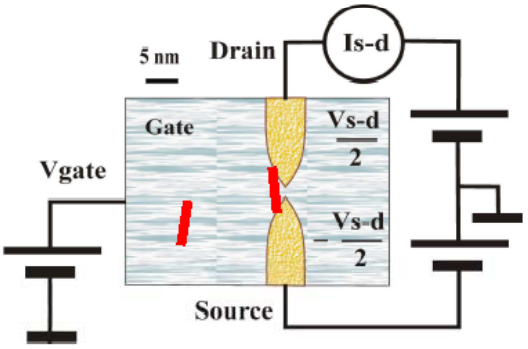




CVD

T = 4 K





Sergey Kubatkin

Nature, **425** 698 (2003).

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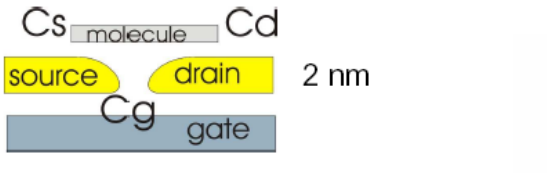
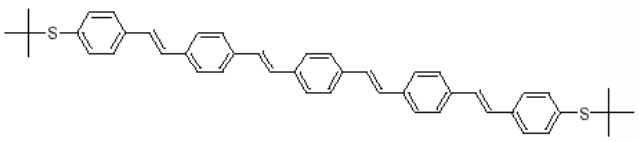
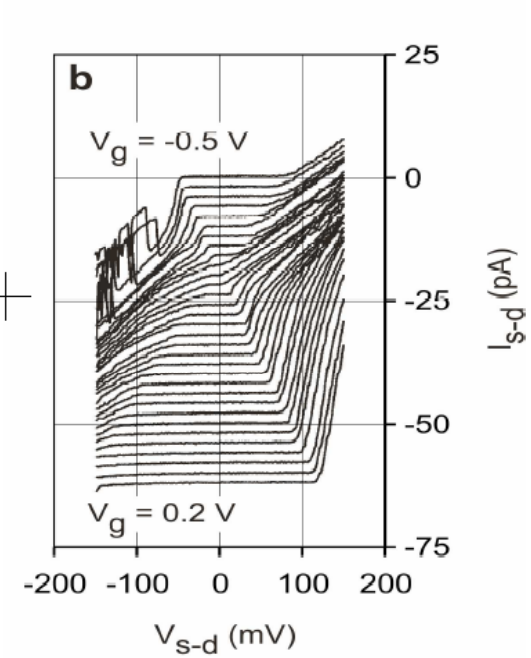
Single molecule single electron transistor







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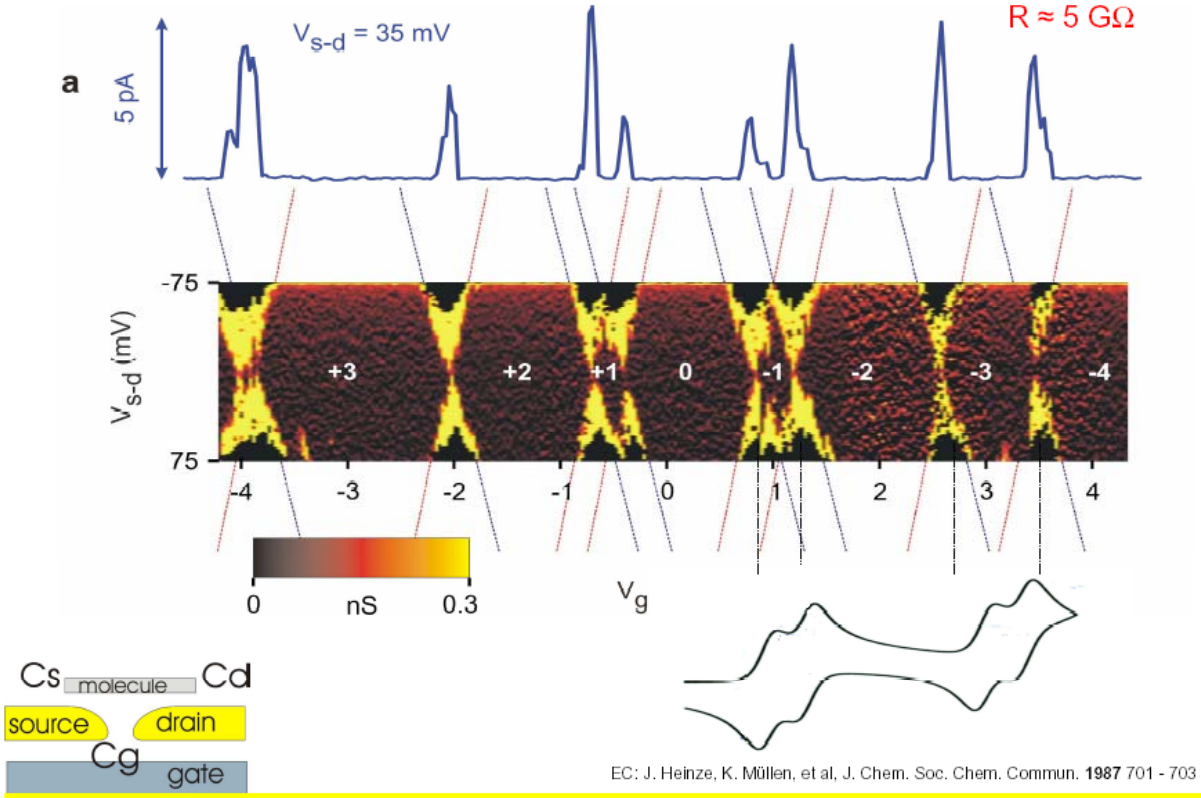

EC: J. Heinze, K. Müllen, et al, J. Chem. Soc. Chem. Commun. **1987** 701 - 703

$$I(n \rightarrow n+1) = \mu_{OPV}(n+1,\ 0) - \mu_{OPV}(n,\ 0) = (C_g/(C_s+C_d+C_g))e\ (V_g(n) - V_g(n+1))$$

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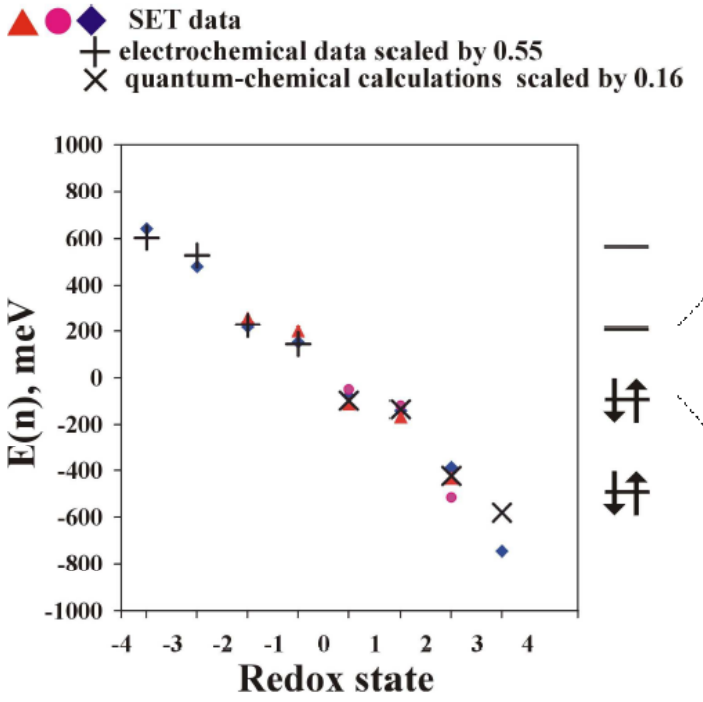
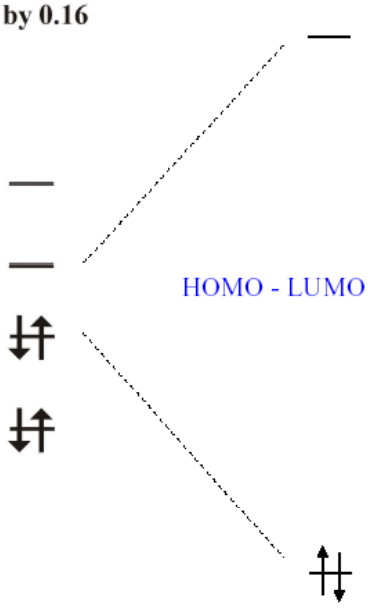
Summary of SET results





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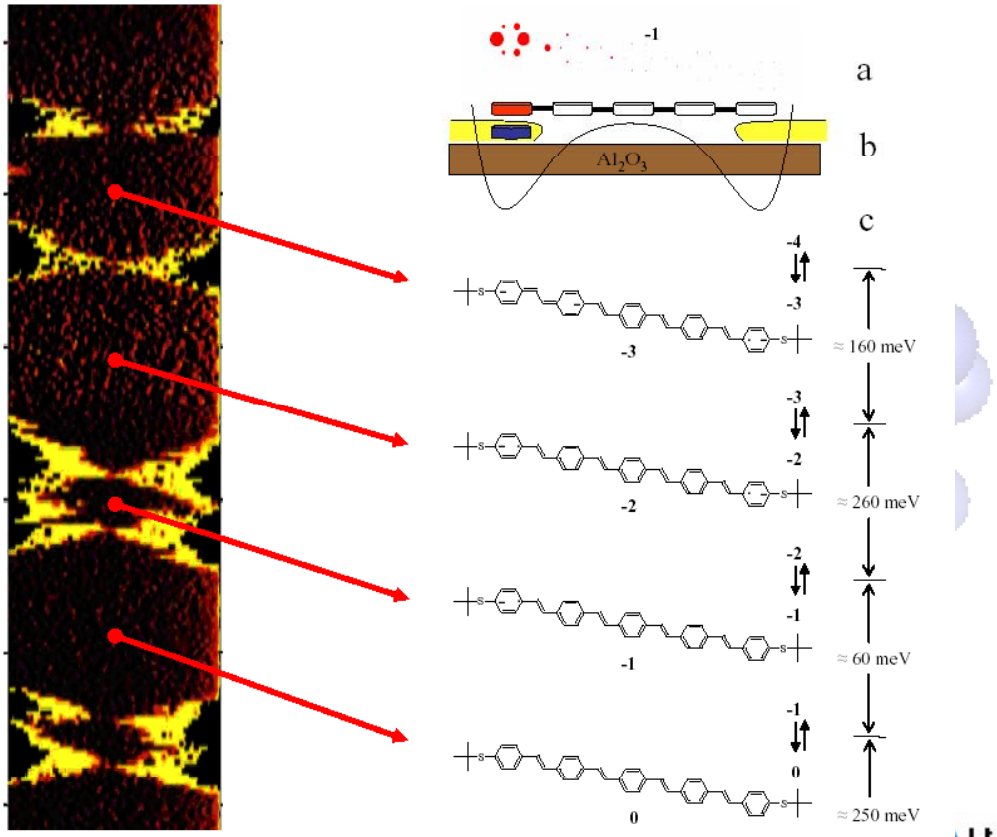

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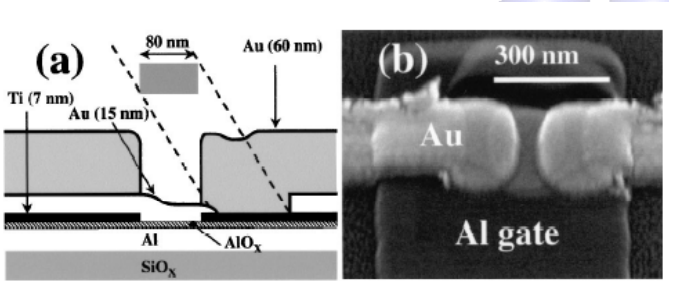
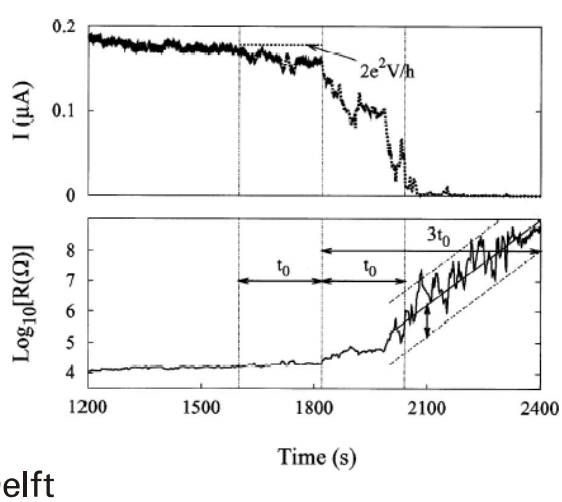
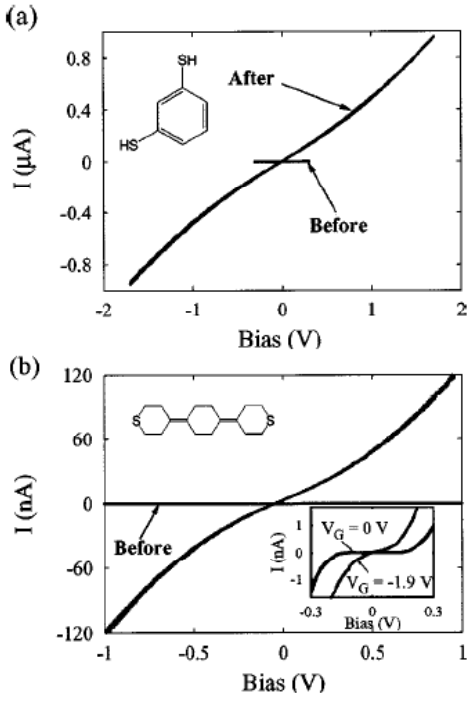
Electroplated planar gap (Y. V. Kervennic et al., 2003)







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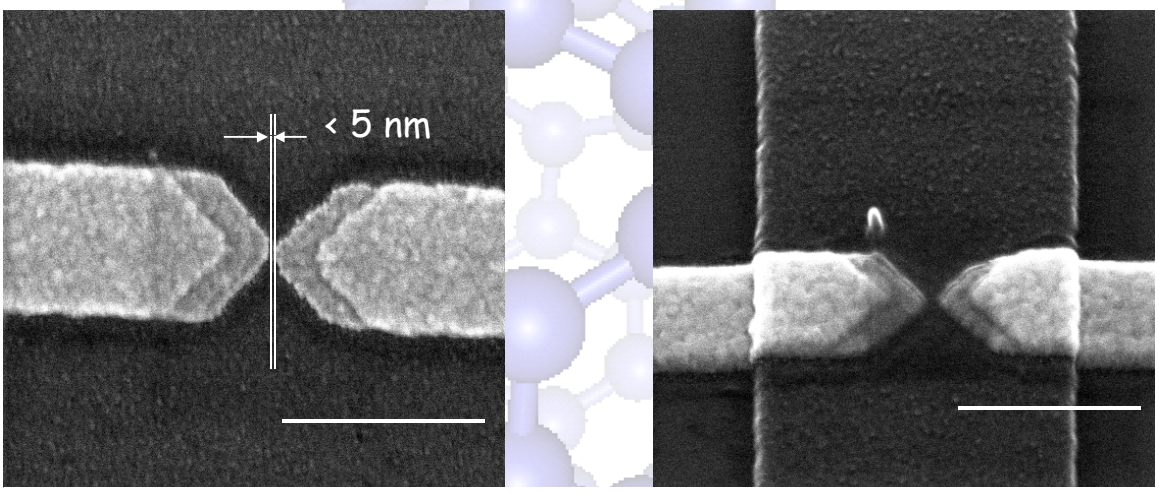
Device Fabrication_planar gap



Small gap defined by e-beam lithography and double angle evaporation (scale bars show 300 nm)

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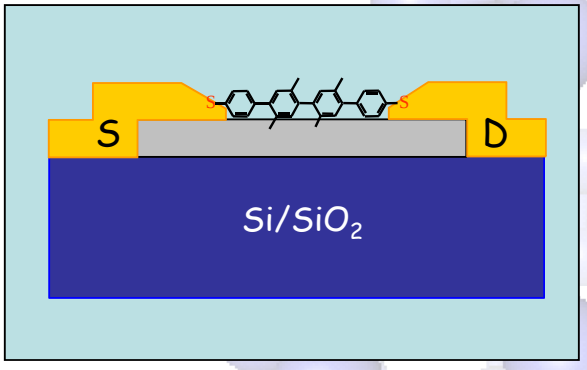

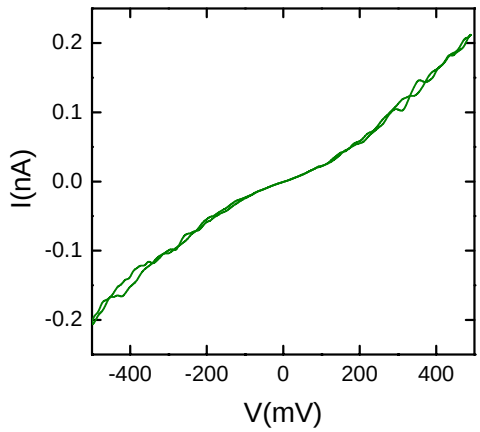

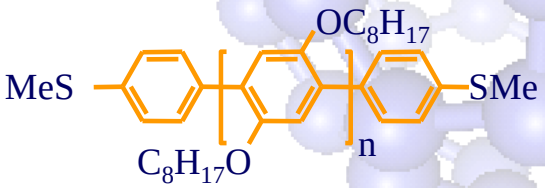

AG180 (~ 8nm)

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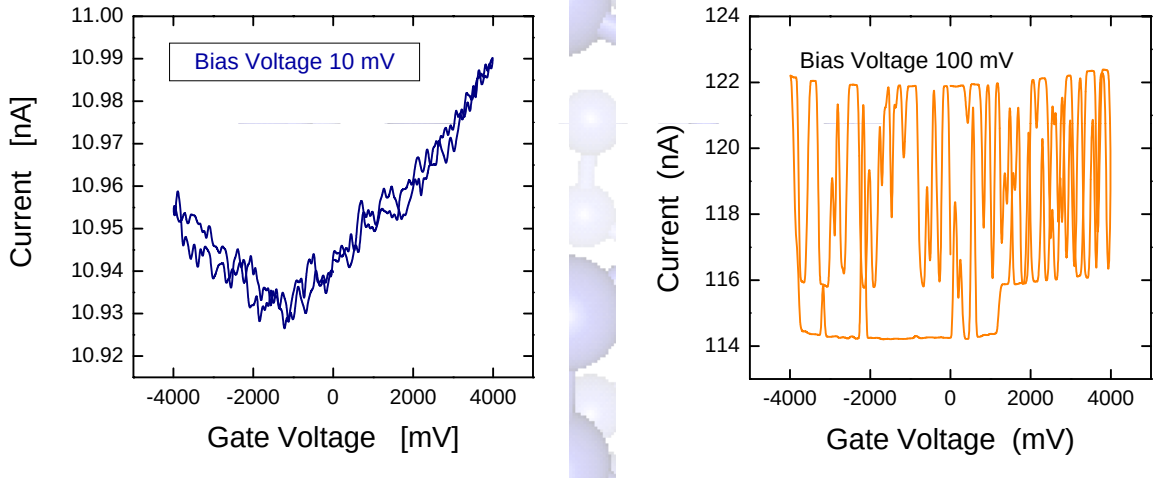
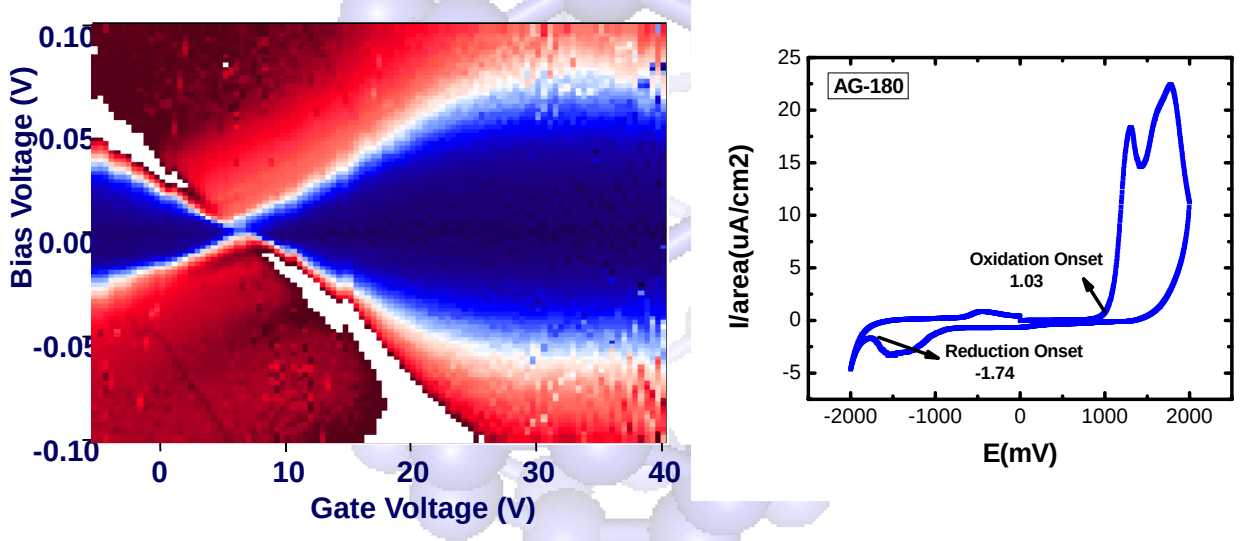
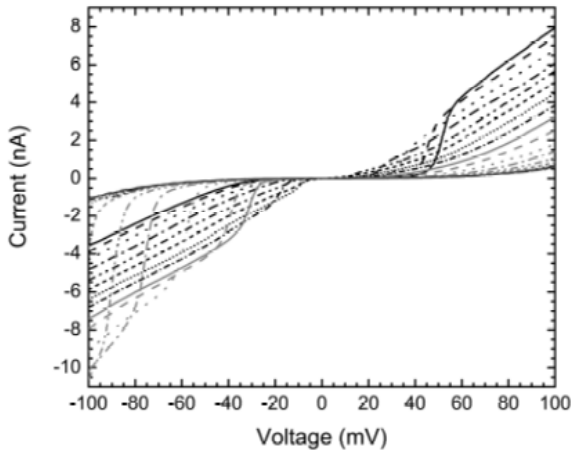


A very small gate effect (0.5% change) is observed, and current is switching between different states at high bias voltage





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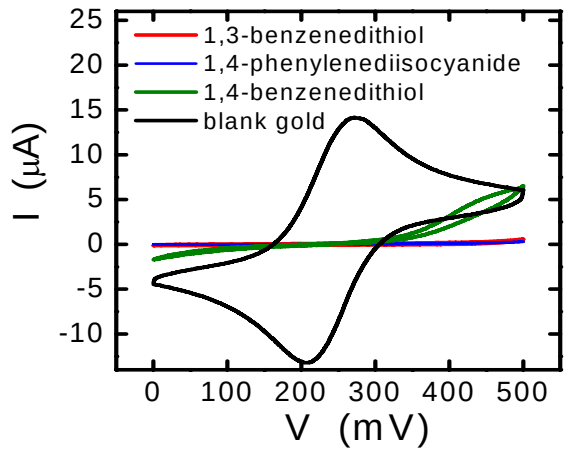

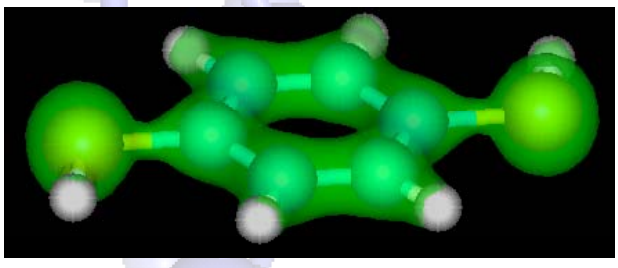

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- AuPd electrodes, SiO_2 gate
- Tunnel conductance
- Molecule solution

BE	after	before	after	before	after
20M	200K	2G	100M	5G	20M
2G	5M	1G	10M	2G	37M
5G	10M	500M	5M	3G	40M
10M	50K	5G	5M	45M	1.9M
5M	500K	20M	5M	4G	5.2M
10M	3M	Open	100M	open	865M

Such a dramatic change has not occurred in the devices fabricated with 1,4-phenylene diisocyanide

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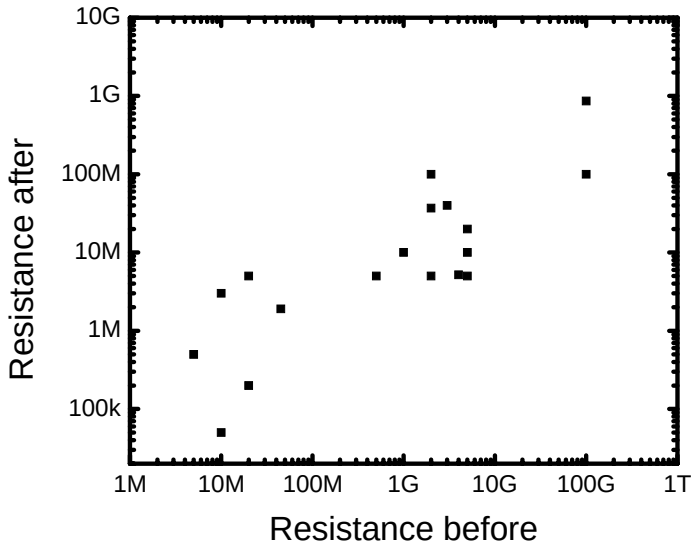

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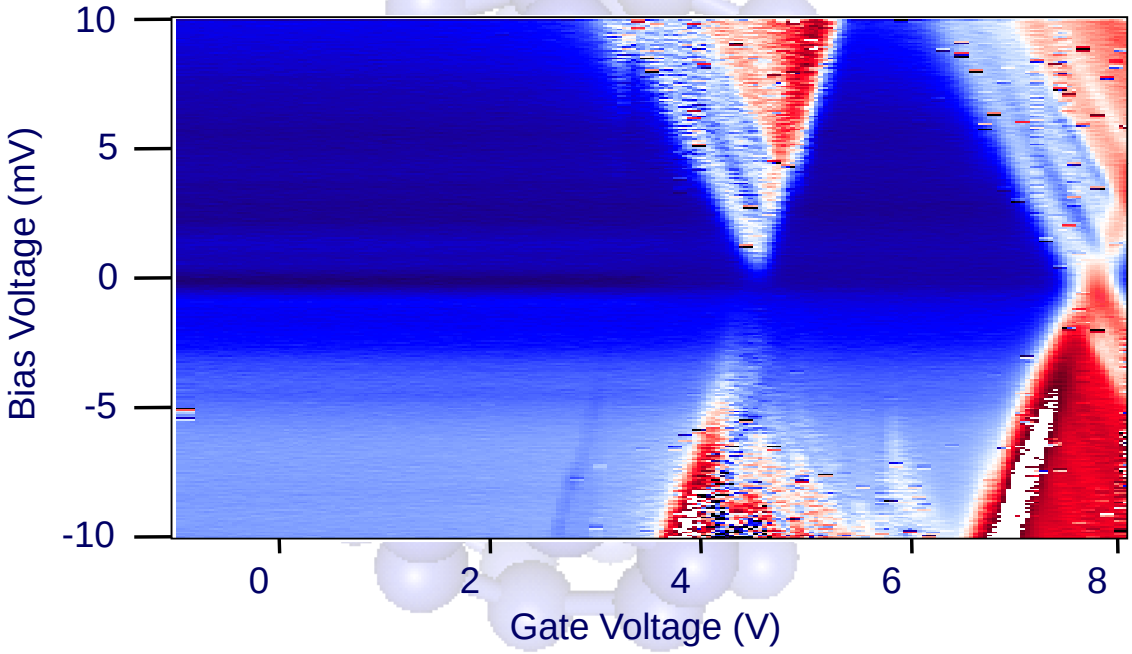

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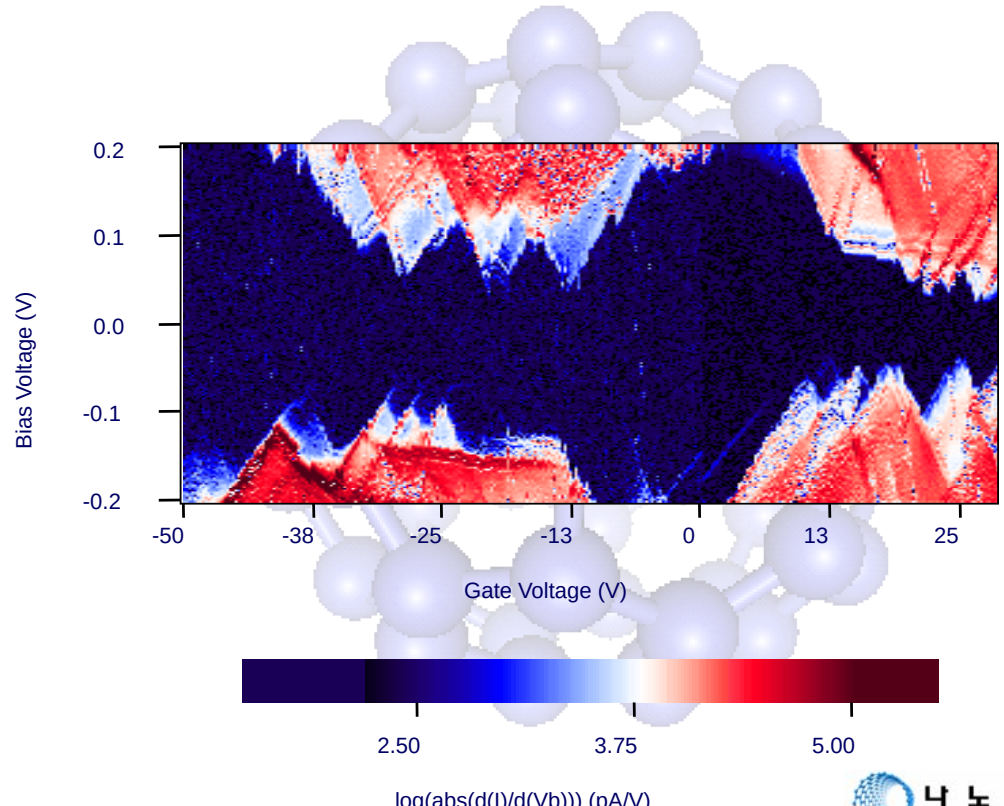

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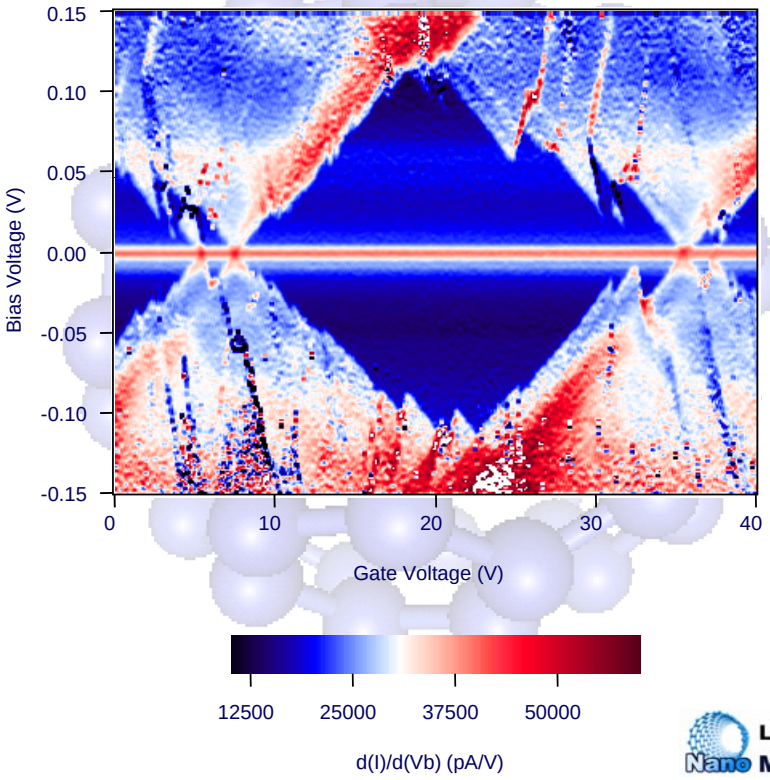
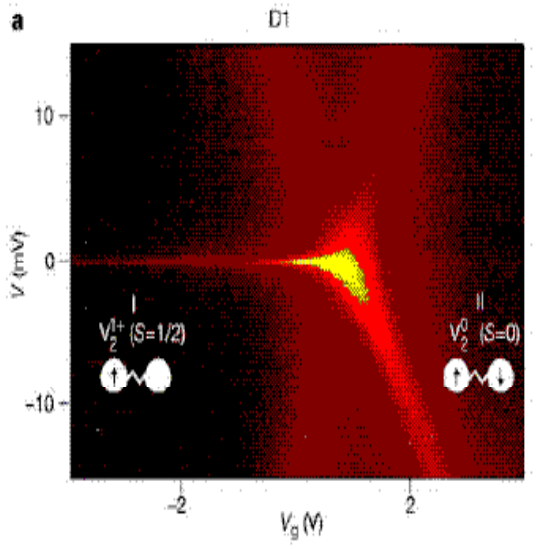
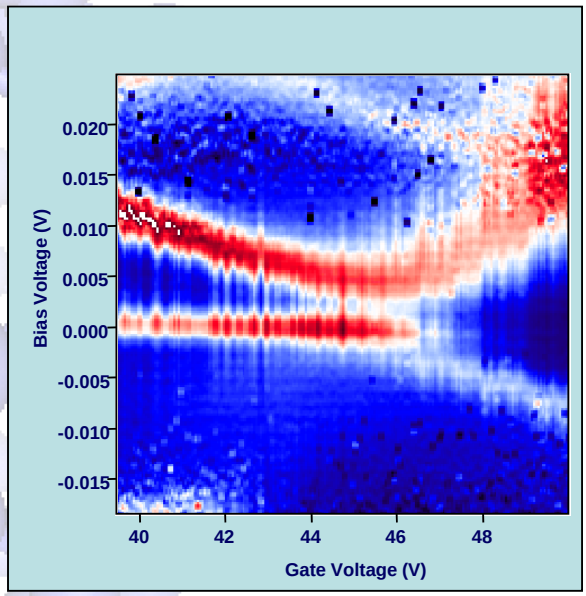


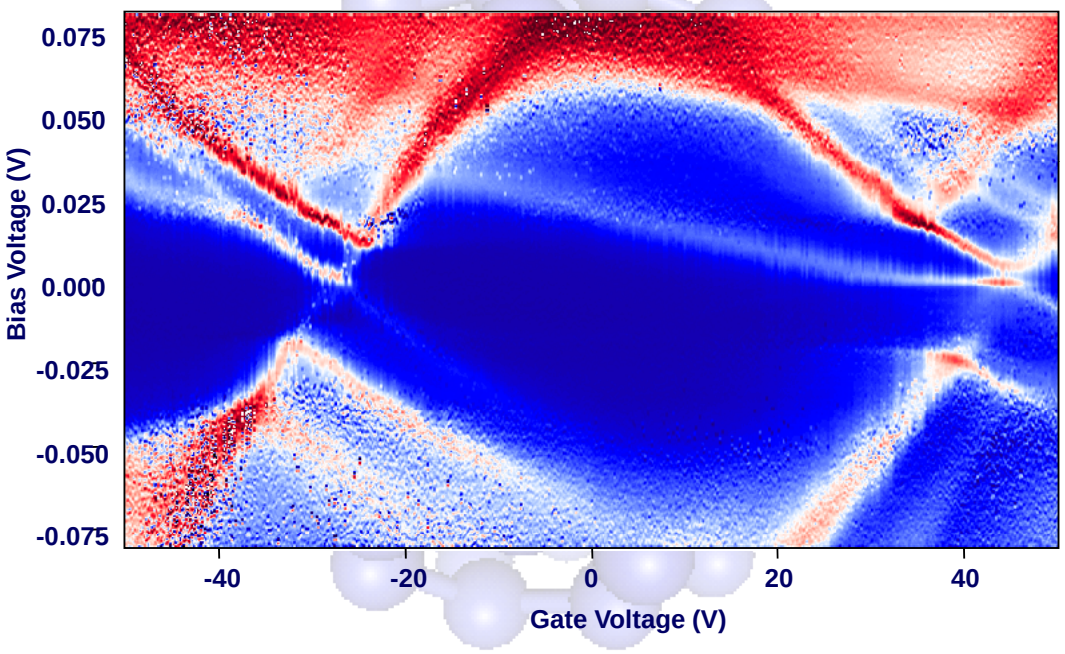
Kondo-effect in 1,4-bezenedithiol?





Liang et al., Nature **417**, 725 (2002)

Lee et al., (2003)



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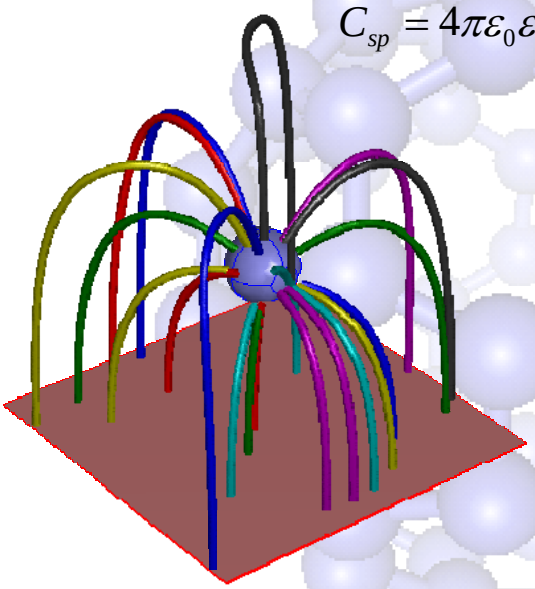
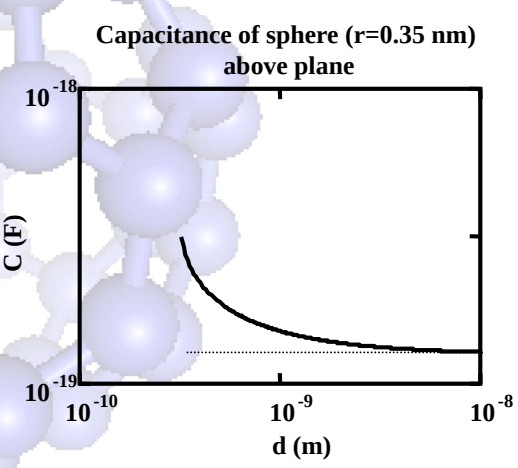
Capacitance calculation of a nanoscale object

$$C_{sp} = 4\pi\varepsilon_0\varepsilon_r\sqrt{d^2 - r^2}\sum_{n=1}^{\infty}\frac{1}{\sinh\left(n\cdot\operatorname{arcosh}(d/r)\right)}$$





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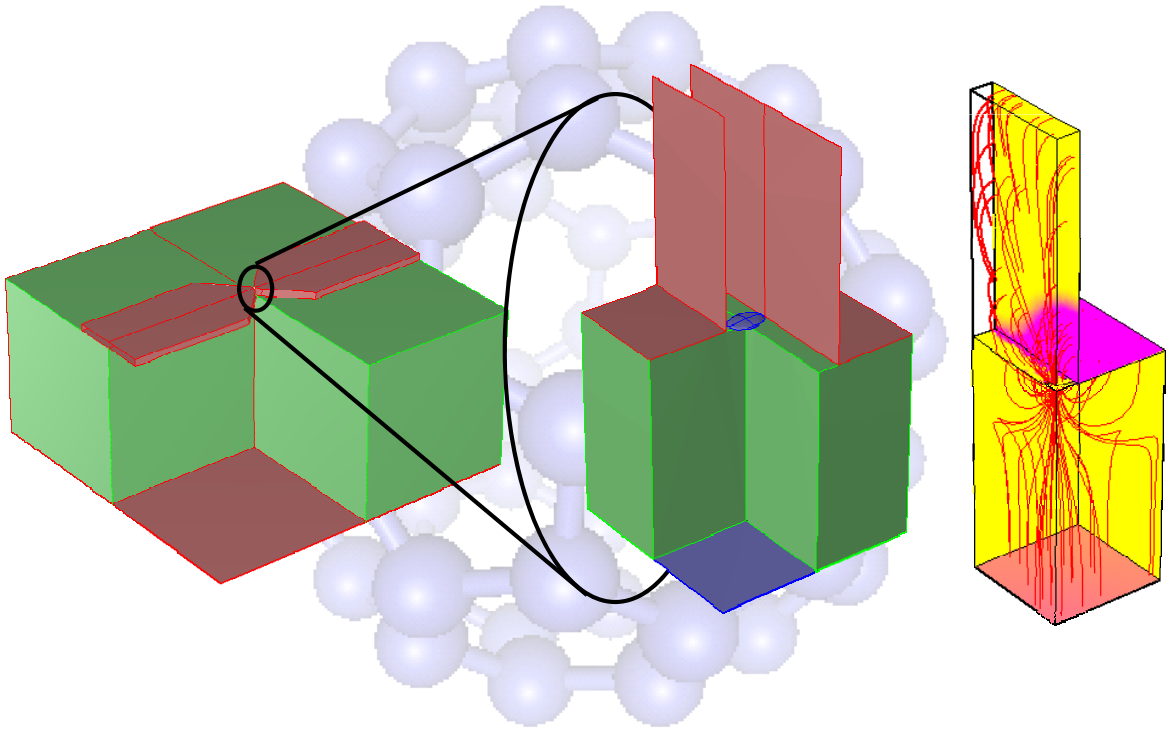

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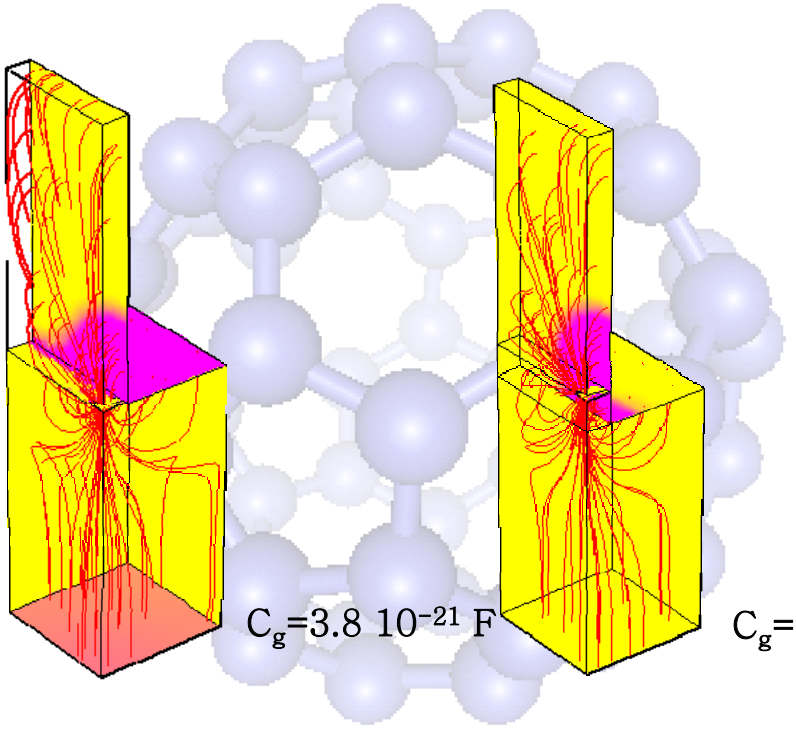

C_g=3.8 10^{-21} F

C_g=2.6 10^{-22} F

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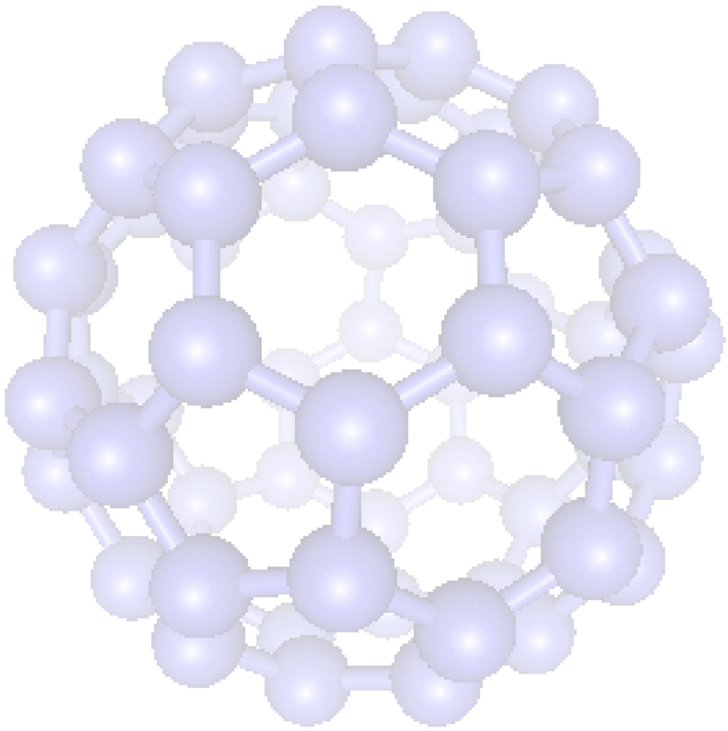

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