

Light-powered switching an entire monolayer: a switchable interface for organic electronics

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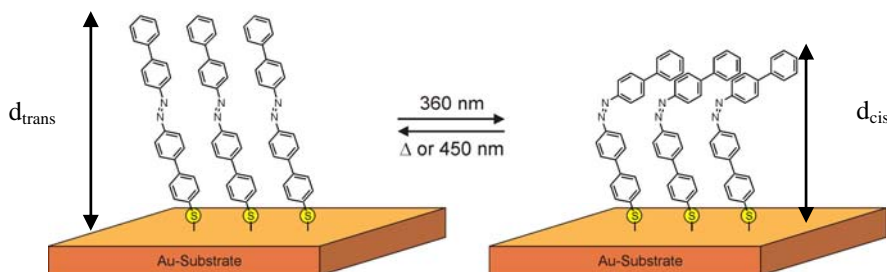
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Nature exploit to a great extent light as a source of energy for operating biological systems. Among photochromes which can convert photonic energy into mechanical energy, azobenzenes have been extensively studied for their unique photoisomerization, potentially enabling switching properties in molecular devices. This is the first study carried on fully conjugated and rigid azobenzene derivatives exhibiting reversible trans-cis photo-isomerization when organized in single-component SAMs on Au(111). High-resolution STM images showed that the AZO molecules undergo light-induced isomerization from the trans to the cis form. Such a switch is extended over many adjacent molecules arranged into 2D crystalline domains. The long range order found for the cis-domains can be explained in terms of a cooperative nature of the process[1]. The stabilization of the intermolecular interactions among adjacent molecule in the SAM is responsible for the considerably increased yield of isomerization on the surface with respect to solution. Such an azobenzene SAM has been successfully used to modulate the current through metal-organic-metal junctions. By incorporating the azobenzene SAM between a Au(111) support and a metal coated AFM tip, we could detect a 30-fold difference in the current through the junction, providing the first example of conducting AFM measurement on a bi-stable system. [2]

Given the occurrence of the isomerization on many thousands adjacent molecules, i.e. on the several hundreds of micrometers scale, we employed a macroscopic mercury drop as counter-electrode and found a reversible change of 1.5 orders of magnitude in the current.

Significantly, the *cooperative and high yield* of switching of many adjacent molecules, chemisorbed on Au was also employed to generate forces acting simultaneously against gravitational effects, atmospheric pressure, and surface tension on a heavy Hg drop. The joint effort of 10^{11} adjacent molecules, each of them exerting a force of at least 2.6×10^{-14} N, led to the generation of an overall force per unit area as high as 1×10^5 N/m². This unambiguously demonstrates that our azobenzene SAM represents a prototype of a molecular machine able to transport mass, and in particular to act as a cargo lifter.

Noteworthy, our *cis-trans* photoisomerization is fully reversible. In principle it might be used to *gate optical signals*, and therefore has potential for *implementing logic operations on arrays of switching elements*, and ultimately for *high density data storage* based on artificial molecular systems.



References

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