Nanoelectronics: High performance nano-switches
The efficiency of a nano-switch can increase ten-fold by adding one extra carbon unit to it

Researchers at the Department of Chemistry, National University of Singapore (NUS) have collaborated with Tyndall National Institute at University College Cork (UCC) to develop nano-scale switches made of organic molecules for high performance energy-efficient electronics. The devices are able to convert current ten times more efficiently, reproducibility is two to three times better, and there is a 10% increase in the yield of working devices.

These new nano-switches possess the potential to drive the miniaturization beyond the limits being approached by conventional semiconductor technology and could give rise to portable devices with greater computational power and longer battery life. This research breakthrough was published in *Nature Nanotechnology*. Assistant Professor Christian Nijhuis from the Department of Chemistry, NUS and Dr Damien Thompson from the Tyndall National Institute in UCC designed and created the devices, which are based on molecules acting as electronic switches.

The fascinating observation is that by adding a single carbon unit (CH_2 group) to the device such that it has an odd number of carbon units, the performance can be increased dramatically. Although others have studied this effect, Assistant Professor Nijhuis and Dr Thompson are the first to show that it can be used to improve the performance of working nano-switches.

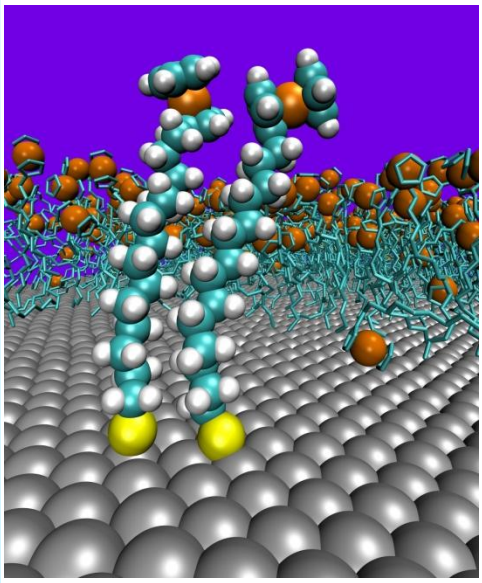

Figure 1: Redox active ferrocene-alkanethiol molecules pack together and assemble into monolayer thin films on silver electrodes. Molecules that stand tall instead of crouching form tighter assemblies, which dramatically improves the device properties.
[Image source: Nature Nanotechology]

Computer simulations have shown that the molecules with an odd number of carbon atoms are able to pack more densely and stiffer than comparable molecules with an even number of carbon atoms due to favourable van der Waals interaction at the molecular level. Dr Nijhuis's team fabricated tightly-packed assemblies of these molecular nano-switches on metal electrode surfaces and found them to be relatively free of defects. Defects cause unwanted current leakage and being defect-free, both the efficiency and the yield of working devices increases.

The nano-switches are fabricated from molecules that act as diodes - a two terminal device which allows current to flow in one direction while blocking it in the other direction. This new research opens up the possibilities of improvements in device performance by taking into account the minute interactions at the molecular level when designing organic electronic components.

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