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Molecular switches get stable when surrounded

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Researchers at Pennsylvania State University, the University of Oregon and Rice University, all in the US, have stabilized the electrical switching of single molecules by altering their environment. The scientists surrounded oligo(phenylene-ethynylene) (OPE) molecules with a self-assembled monolayer.

"If we can stabilize and control the conductance state [of the molecules], we are closer to developing molecular memory components," said Paul Weiss of Penn State University. "The chemical interactions that we observed reduce random switching, which could decrease the refresh rate needed for a random-access-memory device and significantly reduce power usage."

To achieve their results, Weiss and colleagues inserted molecules of the OPE 4-(2'-nitro-4'-phenylethynyl-phenylethynyl)-benzenethiol (NPPB) into a self-assembled monolayer of amide-containing alkanethiols on a gold surface. Since the NPPB molecules were both longer and more conductive than the surrounding alkanethiols, they appeared as protrusions in a scanning tunnelling microscope (STM) image.

STM imaging also revealed the conductance state of the molecules. Molecules in a high conductance (or "ON") state appeared higher than those in a low conductance state.

At a positive sample bias, the NPPB molecules showed a strong preference for the "ON" state. The researchers believe that hydrogen bonding between amide groups in the monolayer gave a more rigid host matrix, reducing the random switching of the embedded NPPB molecules.

With a negative sample bias, on the other hand, the molecules preferred the low conductance state.

This bias-dependent switching has only been seen when both the amide group in the monolayer and the nitro group in the OPE were present. As a result, the scientists reckon that hydrogen bonding between these two groups was a key factor.

"Next, we are engineering molecules and their interactions with their surroundings to provide further control of function," said Weiss.

The researchers reported their work in the *Journal of the American Chemical Society*.

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