



Electronic Motor Based on Single Tripodal Chiral Molecule

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Abstract:

We present our results concerning a single molecular motor driven by the current in an STM. The investigated molecules are tailor-made in the group of Prof. Mayor. The three anchoring groups fix the molecules to the Au(111) surface they are deposited onto (see Fig.1). The functional group is supposed to perform a rotation in a preferred direction with respect to the anchoring groups. The proposed mechanism to drive the directed motion is based on the chiral-induced spin selectivity (CISS) effect. This effect causes the electron spin of an injected current to be polarized after passing through a chiral electric field [1]. This spin polarization exerts a torque on the functional group via spin-orbit coupling. Therefore, the functional group is chosen to be chiral. By comparison with previously studied, similar molecules, it can be concluded that the molecules adsorb with the anchoring groups on the Au(111) surface. This leaves the chiral group roughly perpendicular to the surface and free to rotate.

Indeed, when positioning the tip above the molecule, abrupt changes in the tunneling current can be observed. Tip positions can be found where the current switches between three distinguishable current levels without moving the tip (see Fig.2). These current levels are interpreted as metastable rotational states (called A,B and C) of the molecule. That way, two directions A->B->C and C->B->A can be defined. A binomial test is used to determine whether the surplus of rotational switches in one direction compared to the other is statistically significant. Our measurements show clearly, that the observed directional rotation is statistically significant. The highest ratio observed in the switching events in the different directions is 489 to 36.

In addition, bias voltage dependent measurements were performed. Here, we see a clear trend that the number of switching events increases monotonically with increasing bias. However, the asymmetry in the switching events, which is a measure for the drive of the directed motion, exhibits non-monotonic behavior.

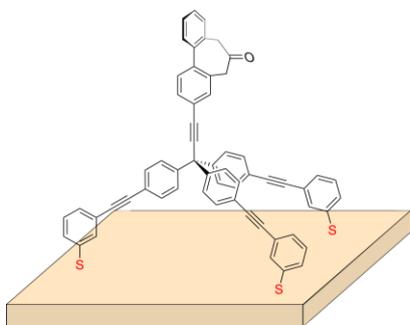


Fig.1: Molecular Motor Molecule

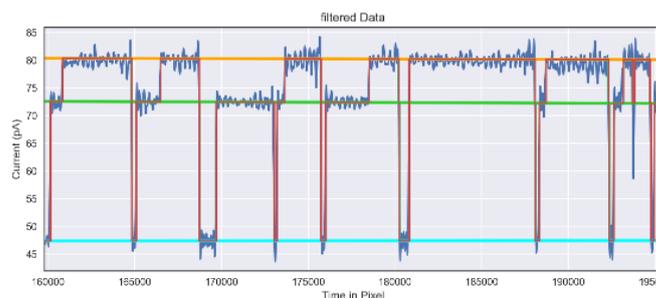


Fig.2: Example of measured metastable current levels

References:

[1] Naaman, R.; Waldeck, H.; Chiral-Induced Spin Selectivity Effect, J. Phys. Chem. Lett. 2012, 3, 16, 2178 - 2187