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Diarylethene self-assembled monolayers on cobalt with high conductance switching ratio for spintronics

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The use of photochromic and electrochromic active molecules in molecular junctions allows modulating the electron transport response of these molecular junctions using light or electric field. When these molecules are used with ferromagnetic (FM) electrodes, the spin-polarized electron transport through the FM/molecules/FM junctions will depend on the conformation of the molecules and the molecule/electrode atomic contact geometry, as evaluated from theoretical studies.[1-3] We have recently reported the optically induced conductance switching at the nanoscale (conductive-AFM) of diarylethene derivatives self-assembled monolayers (SAMs) on $La_{0.7}Sr_{0.3}MnO_3$ electrodes,[4] and observed a weak conductance switching of the diarylethene molecular junctions (closed isomer/open isomer conductance ratios $R_{c/o} < 8$) and conductance ratio (cis/trans isomers) of about 20 for azobenzene derivatives on Co.[5] Here, we report an unprecedented $R_{c/o} \approx 400$ for diarylethene SAMs on Co (against ≈ 50 for the same SAMs on Au). The molecules (DAE1 and DEA2, see Figure) were designed and synthesized diarylethene for large conductance switching ratios. The electron transport properties of SAMs on Au and Co were measured by conductive atomic force microscopy (C-AFM in air and UHV, respectively) coupled with first principle calculations (Non-Equilibrium Green's Functions combined with Density Functional Theory, NEGF/DFT). The experiments and calculations agree on the following trends: (i) Both molecules show a higher $R_{C/O}$ on Co than Au; (ii) With both metals, the $R_{c/o}$ for DAE2 is higher than for DAE1. We conclude that these DAE molecular junctions on Co are prone to magnetoresistance measurements at the nanoscale (in progress).

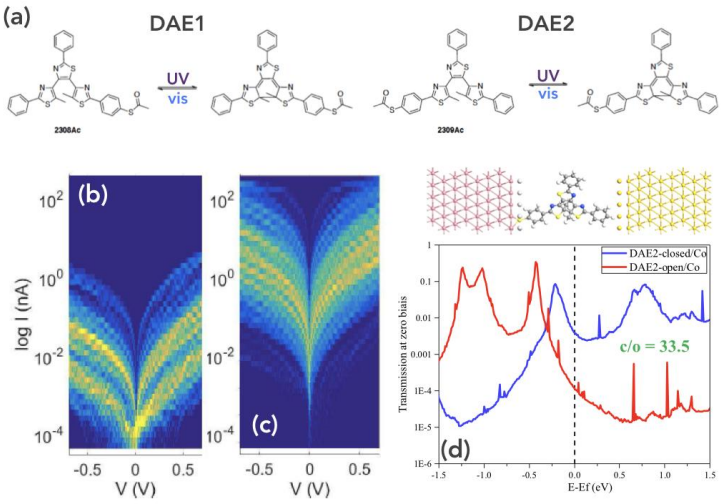

Figure. Scheme of DAE1 and DAE2 (a), 2D histograms of the CAFM tip/DEA2/Co junctions in the open (b) and closed (c) forms, and the calculated transmission coefficients (d).

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