Current-control of instantaneous molecular switching

Sasha Alexandrov *

Department of Physics, Loughborough University, Loughborough LE11 3TU, United Kingdom.

Molecular devices that exhibit bi-stability and fast switching could be the basis of future oscillators, amplifiers and other important circuit elements. Further progress in molecular electronics will depend upon understanding intrinsic mechanisms for their reversible switching from low- to high-current states. In our phenomenological model [1] a molecule has been described as a negative Hubbard-U d-fold degenerate energy level weakly coupled to metallic leads. The exact many-particle Green's functions of the level, the density of states and the non-linear rate equation for the electron density on the molecule have been derived fully taking into account the electron-electron correlations U. We have found the exact solutions for the carrier population in the dot and the current for $d = 2,4,6$ and $d \gg 1$. The current-voltage characteristics show a hysteretic behaviour for $d > 2$ over a finite voltage range. To justify the model we further developed the analytical theory of the correlated transport through molecules fully taking into account strong e-ph interactions and polaronic attractive correlations [2]. The degenerate molecular quantum dot with strong electron-vibron coupling has two stable current states (a volatile memory), which might be useful in molecular electronics.

[1] Alexandrov, A.S., Bratkovsky, A.M. and Stanley Williams, R., Phys. Rev. B 67 , 075301 (2003).
[2] Alexandrov, A.S, and Bratkovsky, A.M., Phys Rev. B 67 , 235312 (2003)

* Corresponding author. Tel. +44 1509223303. FAX +44 1509223986.
Email address: a.s.alexandrov@lboro.ac.uk (Sasha Alexandrov).