Gate controlled hydrogen tautomerisation of Phthalocyanine molecules

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Tautomerisation is a reaction which involves an interconversion between two isomers by simple transfer of proton. Interestingly, the electron transport properties of those two isomers are significantly different. Owning its reproducibility and reversibility, tautomerisation process is a strong candidate for future molecular switches. The first working example of such molecular switch is proposed at 2007, where voltage pulses of the STM tip induce a change in the orientation of the hydrogen atom pair at the center of naphthalocyanine, leading to tautomeric switching between low and high conductance. Later, several methods to control tautomerisation reaction were developed by changing the chemical environment of the molecule. However, those methods are usually limited in their effective spatial range and not always reversible. In this work, by using a gate-tunable STM, we doped the graphene substrate electrostatically to alter the chemical potential around molecule, which results in up to 60 % decrease of the tautomeric switching rate. This reduction is assigned to the increase of the energetic barrier between the two isomers which attributed to the decrease of the tip induced electric field. The gate-tunable STM allows us to control the electric field by varying the tip-sample distance without changing the number of the injected electrons or their relative potential. Understanding and controlling the influence of electrostatic doping and the tip-induced electric field on the molecules will be crucial for constructing the future molecular devices.