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Directing molecular traffic by means of a nano-engineered surface

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The parallel manipulation of individual molecules is the ultimate goal of many current researches in nanosciences. A first route is the confinement of molecular motion until the continuum approximation breaks down and discrete-molecule effects appear, as observed in zeolite analogs or inside nanotubes. A bottom-up alternative consists in surface self-assemblies tailored at the molecular scale. Although most studies on nanostructured surfaces are still focused on their structure, the demonstrations of selective adsorptions inside single-molecule pores, the observation of rotating molecules inside an accidental bearing in a sub-monolayer film, or within self-assembled monolayers, represent pioneering first steps towards functional systems. In this context, we have demonstrated the sorting and routing of individual molecules via surface diffusion inside bottom-up designed molecular sieves. We monitor the operation in-situ and in real time at the single-molecule scale through fast variable-temperature scanning-tunneling microscopy (STM). These studies unravel the mechanisms of molecular filtering. This permits to derive molecular-design guidelines for tuning cavity or channel selectivity. We discuss the opportunity to control optically and locally the molecular motion, using tip-induced field enhancements.