Chirality in flatland: intermolecular recognition, spin filtering and molecular machines at surfaces

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Molecular recognition among chiral molecules on surfaces is of paramount importance in biomineralization, enantioselective heterogeneous catalysis, and for the separation of chiral molecules into their two mirror-image isomers (enantiomers) via crystallization or chromatography. Understanding the principles of molecular recognition in general, however, is a difficult task and calls for investigation of appropriate model systems. One popular approach is thereby studying intermolecular interactions on well-defined solid surfaces, which allows in particular the use of scanning tunneling microscopy (STM). Examples of chiral amplification via the so-called 'sergeant-and-soldiers' effect as well as manipulation of chiral adsorbates via inelastic electron tunneling will be presented. In a Pasteur-type experiment at the nanoscale, molecules that constitute a dimer are spatially separated with a molecular STM tip and their absolute handedness is determined with submolecular resolution STM. Moreover, we report spin-dependent filtering of electrons by monolayers of these helical molecules. Finally the first successful electrical current-driven, unidirectional motion of a synthetic molecule will be presented (Fig. 1).

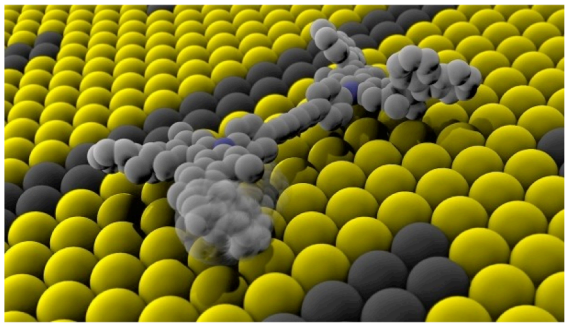

Fig. 1: Sketch of the 'nanocar' on a surface.