Molecular Electronics: from structure property correlations to functional molecules

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Molecules are the smallest objects still providing the structural diversity required to tune their properties in order to design their functions. The challenge to assemble these minute nanoscale building blocks has been addressed by organic chemists since more than a century. Considering the ongoing feature size reduction in semiconductor electronics, the increasing interest in molecules as potential functional units in electronic circuits is not surprising [1]. With the development of the experimental tools required to investigate these objects even on the single molecule level by experimental physicists and physical chemists, an outstanding platform to tackle the interdisciplinary challenge of "single molecule electronics" was created and resulted immediately in an inspiring and fruitful cooperation between scientists from these disciplines.

The ability of single molecules integrated in an electronic circuit to modulate the transport current was investigated by comparing structural variations. Following this approach, entire series of molecules varying in a single structural parameter like e.g. biphenyl cyclophanes with a controlled interphenyl ring torsion angle were synthesized [2-4] and investigated [5,6]. The observed correlation of the transport current with the cos2 of the torsion angle further corroborated the single molecule as the origin of the current variation. First examples of single molecule devises have been developed successfully like e.g. a single molecule rectifier [7].

Recent investigations are geared towards molecular systems combining optical and electronic signals. In a recent single molecule electroluminescence experiment based on a tailor-made molecular rod in a carbon nanotube junction [8], the optical response from the junction provides the unambiguous proof of the molecular nature of the junction [9]. A molecular rod comprising a stable organic radical displayed Kondo coupling in a weak coupled regime [10].

Currently we are interested in molecular switches as well as supramolecular systems reacting on external triggers like e.g. the spacing between both electrodes or the applied electric field.

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