

On-Surface Synthesis of Nanocarbon Structures and Characterization of Their Spin States using Scanning Probe Microscopy

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Abstract:

On-surface chemical reaction has become a very powerful technique to synthesize nanostructures by linking small molecules in the bottom-up approach under ultrahigh vacuum conditions. The structural information as well as electronic and magnetic properties of products are in situ investigated using scanning probe microscopy at low temperature. Recently, this strategy has been applied for the synthesis of single molecules hosting a spin property and its oligomer. The unique spin-spin properties attract interests of researchers.

In this contribution, I will present on-surface synthesis of the nanocarbon structures and characterization of their spin states. We found that diazahexabenzocoronene adsorbed on Au(111) hosts a $S=1/2$ character due to the charge transfer between the substrate and the molecule. By covalently linking these molecules, we realized spin-1/2 Heisenberg molecular chains with a given antiferromagnetic coupling J (Figure A) [1]. These molecular chains show distinct features depending on their parity: gapped excitations for even-numbered spin chains and Kondo excitations for odd-numbered ones. This approach has been expanded to the syntheses of spin-1/2 ring composed of a phenalenyl unit [2], as well as the extended Au-porphyrin (Figure B) [3]. Their magnetic characters were investigated using a tip terminated by a nickelocene molecule. We also found that the magnetic character of the nickelocene molecule is also modulated by the electronegativity of the contacted bromine atoms [4].

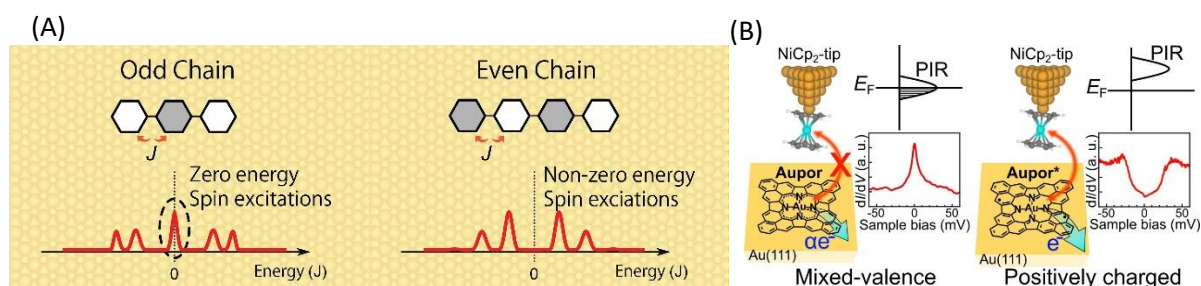


Figure (A) Schematic drawing of Heisenberg $S = 1/2$ antiferromagnetic molecular chains composed of odd and even numbers of molecular units and the corresponding magnetic couplings. (B) Extended Au-porphyrin with phenalenyl units and their magnetic property.

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