

# Molecular charge transitions and on-surface reactions by atomic manipulation

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Elusive molecules can be created using atomic manipulation. High-resolution atomic force microscopy (AFM) with functionalized tips provides insights into the structure, geometry, aromaticity, charge states and bond-order relations of the molecules created and into the reactions performed [1]. Recently we generated the molecular carbon allotrope cyclo[18]carbon and resolved its long debated structure [2] (see Figure).

On insulating substrates, we can control the charge state of molecules by deliberately attaching and detaching single electrons with the tip. We measured the reorganization energy of a molecule [3] and resolved the changes within molecular geometry, adsorption and aromaticity related to its oxidation state [4].

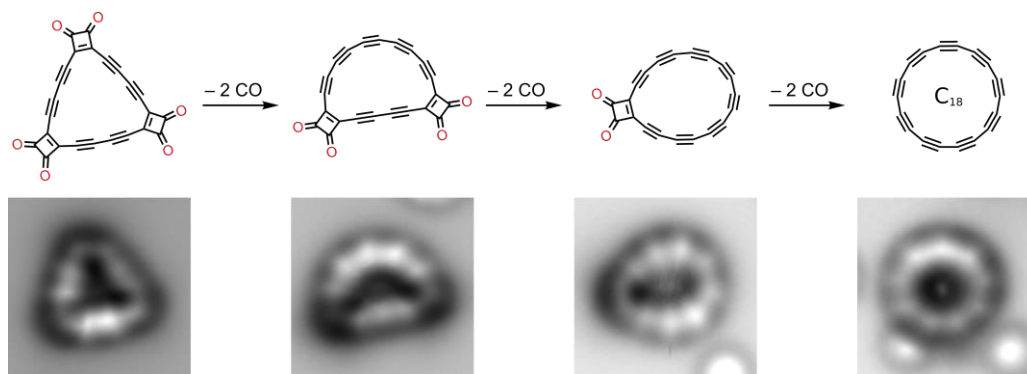


Figure: Cyclo[18]carbon created by atom manipulation on bilayer NaCl on Cu(111). Bottom row: Constant-height AFM measurements with a CO functionalized tip. Reproduced from ref. [2].

## References

- [1] L. Gross *et al.* *Angew. Chem Int. Ed* **57**, 3888 (2018)
- [2] K. Kaiser *et al.* *Science* **365**, 1299 (2019)
- [3] S. Fatayer *et al.* *Nature Nanotechnol.* **13**, 376 (2018)
- [4] S. Fatayer *et al.* *Science* **365**, 142 (2019)