Organometallic Sandwich Complexes: One-Dimensional Molecular Building Blocks for Nanoscale Applications

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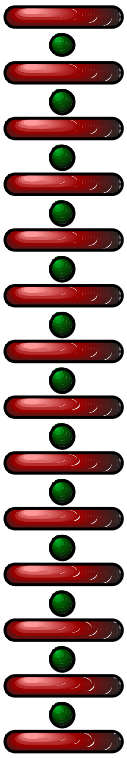
Simple organometallic "sandwich" compounds have been known for decades. The best known example is ferrocene, a molecule consisting of an iron atom "sandwiched" between two (flat) molecules of cyclopentadiene. Research performed in the Chemistry Division of Argonne National laboratory in collaboration with Atsushi Nakajima and his group from Keio University and with Koji Kaya of the Institute for Molecular Sciences (Japan) has shown that multilayer sandwich compounds larger than those ever observed before can be formed by reacting laser-generated metal atoms with benzene (and benzene derivatives) or cyclooctatetraene (COT) at low temperatures. Moreover, these multidecker sandwich compounds are paramagnetic, as demonstrated by molecular beam deflection experiments. The largest such sandwich molecule found thus far is a 19 layer complex formed by reacting europium atoms with COT at –210 ºC. There does not appear to be any fundamental limitation to the number of layers that can be produced, suggesting that one-dimensional multilayer sandwhich compounds many nanometers in length could be synthesized under proper conditions. Such one-dimensional molecules may find uses as building blocks in nanoscale devices or materials. The observation that these chain-like molecules are paramagnetic, for example, suggests they might find application as one-dimensional nanomagnets or nanowires.



Side view of the $Eu_{13}(COT)_{14}$ complex. Complexes up to $Eu_{18}(COT)_{19}$ have been observed. Similar multilayer complexes have been produced by reacting Sc, Ti, V, Cr, and Mn atoms with benzene (and its derivatives) and by reacting Pr, Eu, Tb, Ho, Er, and Yb atoms with COT.

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