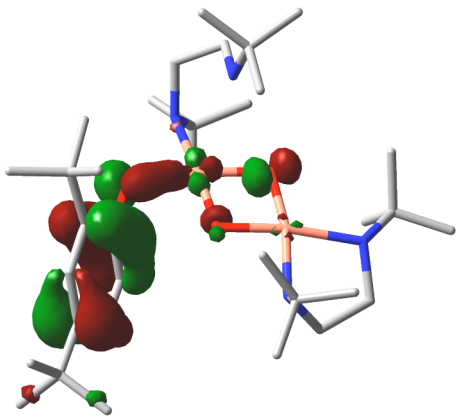
Tyrosinase Reactivity in a Model Complex: An Alternative Hydroxylation Mechanism

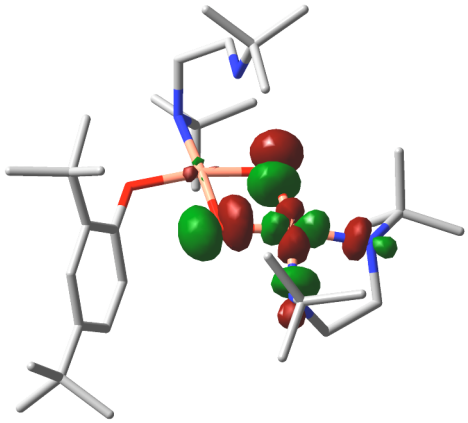
Liviu M. Mirica, Michael Vance, Deanne Jackson Rudd, Britt Hedman, Keith O. Hodgson, Edward I. Solomon, and **T. Daniel P. Stack**.

Department of Chemistry, Stanford University, California 94305
Stanford Synchrotron Radiation Laboratory, SLAC, Stanford University, California

The binuclear copper enzyme tyrosinase activates O_2 to form a μ-η^2:η^2-peroxodicopper(II) complex which oxidizes phenols to catechols. A synthetic, spectroscopically faithful μ-η^2:η^2-peroxodicopper(II) complex, capable of aromatic hydroxylation at –80 °C, forms a reactive intermediate upon phenolate addition at extreme temperatures (–120 °C). Detailed spectroscopic characterization supports a bis-μ-oxodicopper(III)-phenolate complex, in which the O–O bond is cleaved. The subsequent hydroxylation step has the hallmarks of an electrophilic aromatic substitution, similar to tyrosinase. DFT calculations on this system strongly support that the bis-μ-oxodicopper(III) species can serve as an electrophilic agent. Overall, in this synthetic complex, the evidence for sequential O–O bond cleavage and C–O bond formation suggests an alternative intimate mechanism for phenol hydroxylation, as compared to that generally accepted for tyrosinase.



HOMO



LUMO