N-DEALKYLATION BY IRON–PEROXO COMPLEXES: A DFT STUDY

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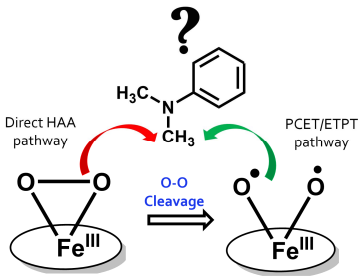
Mononuclear iron-containing oxygenases categorized as heme and nonheme enzymes utilize dioxygen (O_2) to catalyze a wide range of oxidative transformations.[1] While high-valent iron(IV)-oxo species are well-established as key oxidants in these systems,[2] iron(III)-peroxo complexes have traditionally been regarded as nucleophilic species.[3] However, only a limited number of studies have explored their involvement in electrophilic oxidation reactions.[4,5] In this study, we explore the reactivity of iron(III)-peroxo complexes ligated by tetramethylated cyclam (TMC) ligands- $[Fe^{III}(O_2)(12\text{-TMC})]^+$ (**1**), $[Fe^{III}(O_2)(13\text{-TMC})]^+$ (**2**), and $[Fe^{III}(O_2)(14\text{-TMC})]^+$ (**3**) toward the N-dealkylation of dimethylaniline (DMA), using density functional theory (DFT) calculations. Our results show that a direct nucleophilic attack by the iron(III)-peroxo species on DMA is both thermodynamically and kinetically unfavorable. Instead, the reaction proceeds via homolytic O-O bond cleavage to generate an iron(III)-dioxyl intermediate, which then performs an electrophilic attack on DMA to generate N-dealkylated species. Furthermore, we demonstrate that subtle changes in the TMC ring size modulate the reactivity and energy barriers of the transformation. These findings offer new mechanistic insights into the oxidation chemistry of synthetic nonheme iron-peroxo complexes and broaden their perceived reactivity beyond classical nucleophilic pathways.



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[3] Kovaleva, E. G.; Lipscomb, J. D. *Nat. Chem. Biol.* **2008**, *4*, 186-193.

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