Mechanistic Studies and Applications of Nickel-Catalyzed Csp^3-Csp^3 Kumada Cross-Coupling Reactions

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In nickel-catalyzed alkyl-alkyl cross-coupling reactions, paramagnetic Ni(I) and Ni(III) species are proposed to be the active intermediates. Herein, we report the use of a bulky ligand, 1,4,7-triisopropyl-1,4,7-triazacyclononane (iPr_3TACN), that facilitated the detection or isolation of uncommon organometallic Ni(I) and Ni(III) complexes involved in well-defined oxidative addition, transmetalation, and reductive elimination steps. Moreover, (iPr_3TACN)Ni(II) complexes were shown to be efficient catalysts for alkyl-alkyl Kumada cross-coupling. The presence of acetonitrile and other alkyl nitriles led to an increased yield of cross-coupled products, and the multifaceted beneficial role of the nitrile additive during catalysis was thoroughly investigated. Furthermore, this catalytic system demonstrated wide functional group and heterocycle tolerance, allowing late-stage diversification of biorelevant molecules without the use of expensive chemical reagents.