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Title:	Merging Photoredox with Organocatalysis and Nickel Catalysis: Accessing Novel Mechanistic Platforms for C–C and C–O Bond Formation
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Abstract:	Visible light photoredox catalysis has emerged in recent years as a powerful technique in organic synthesis due to its ability to generate non-traditional sites of reactivity on organic substrates via low-barrier, open-shell pathways. Importantly, the mild conditions employed by photoredox catalysis, particularly the use of low-energy visible light, enable its synergistic merger with diverse catalytic platforms to accomplish previously elusive transformations through a series of single electron transfer events. This thesis describes the successful merger of photoredox catalysis with enamine organocatalysis, hydrogen atom transfer catalysis, and nickel catalysis to accomplish new strategies for C–C and C–O bond formation. In combination with enamine organocatalysis, photoredox catalysis opens up direct β -functionalization of saturated carbonyls with a wide range of coupling partners, enabling the direct β -alkylation of aldehydes with Michael acceptor coupling partners. Selective functionalization of strong C–H bonds in the presence of weaker bonds has been demonstrated via a combination of photoredox-mediated hydrogen atom transfer and hydrogen-bonding catalysis. We have developed a novel cross-coupling manifold, through the merger of photoredox and nickel catalysis, whereby native functionality – such as carboxylic acids and sp^3 C–H bonds – can be employed as latent nucleophiles in cross-coupling. This insight led us to the understanding that photoredox catalysis can modulate nickel oxidation states through single electron transfer events to enable elusive organometallic reactivity. By taking advantage of this oxidation state manipulation, we have been able to switch on a general method for challenging nickel-catalyzed C–O coupling with aryl halides and alcohols.
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