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Nickel-Catalysed anti-Markovnikov Hydroarylation of Unactivated Alkenes with Unactivated Arenes Facilitated by Non-Covalent Interactions
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Nickel-Catalyzed anti-Markovnikov Hydroarylation of Unactivated Alkenes

Significance: Nakao, Hartwig and co-workers report a novel nickel-catalyzed undirected hydroarylation reaction between unactivated alkenes and unactivated arenes. The reaction proceeds in excellent yields with high selectivity for the anti-Markovnikov product. These products are distinct from those accessed through acid-catalyzed processes.

Comment: The authors characterized the catalytically relevant substrate bound nickel complexes and identified the reductive elimination step forming the C–C bond as the rate-limiting step. They also note that differences in the activity between catalysts with large/small carbenes are more dependent on the stabilizing intramolecular noncovalent interactions in the secondary coordination sphere, than steric hindrance.

Selected examples:

<table>
<thead>
<tr>
<th>Ph</th>
<th>C8H17</th>
<th>L1: 96% yield</th>
<th>L2: 92% yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph</td>
<td>Si OTMS</td>
<td>Li: 92% yield</td>
<td>Li: 90% yield</td>
</tr>
<tr>
<td>Ph</td>
<td>Si OTMS</td>
<td>Li: 92% yield</td>
<td>Li: 90% yield</td>
</tr>
<tr>
<td>F</td>
<td>C8H17</td>
<td>L1: 95% yield</td>
<td>L2: 96% yield</td>
</tr>
<tr>
<td>F</td>
<td>CF3</td>
<td>L1: 95% yield</td>
<td>L2: 95% yield</td>
</tr>
<tr>
<td>CF3</td>
<td>Me</td>
<td>L1: 91% yield</td>
<td>L2: 91% yield</td>
</tr>
</tbody>
</table>

Proposed mechanism:

Resting state is concentration-dependent for hindered alkenes

Rate-limiting reductive elimination

Ligand–ligand H-transfer

Isomerization

Rate-limiting reductive elimination

Resting state for unhindered alkenes

Selected examples:

- [L-Ni(η⁶-C₆H₆)] (3 mol%)
- NaH (2.0 mol%)
- Na(acac) (5 mol%)

neat, 120 °C, 24 h

15 examples
up to 88% yield
up to 3.0 mmol scale

ligand 1 = Ar = 3,5-Me₂C₆H₃

ligand 2 = Ar = 3,5-Et₂C₆H₃

SYNFACTS Contributors: Mark Lautens, Randy Sanichar

Category: Metals in Synthesis

Key words: nickel catalysis, C–H activation, hydroarylation, unactivated alkenes, anti-Markovnikov reaction