Fe-, Co- and Cu-Catalyzed Coupling Reactions Using N$_2$O

**Significance:** For the first time, N$_2$O (‘laughing gas’) is reported to undergo oxidative homo-coupling reactions of Grignard reagents in the presence of metal catalysts under mild reaction conditions. Whereas less than 1 mol% of Fe(acac)$_3$ and CoCl$_2$ showed to be superior in the homo-coupling reactions of arylmagnesium reagents, also alkyl Grignard reagents undergo oxidative homo-coupling reactions in the presence of Li$_2$CuCl$_4$.

**Comment:** The authors applied this new protocol also to oxidative cross-coupling reactions between sp$^2$- and sp$^3$-hybridized Grignard reagents. Therefore, PhMgCl and various primary and secondary alkyl Grignard reagents furnish the desired aryl-alkyl cross-coupling products in 59–83% yield.

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Oxidative homo-coupling of aryl, alkenyl and alkyl Grignard reagents:

$$\begin{align*}
2 \quad R\text{MgX} & \xrightleftharpoons[\text{metal salt (<1 mol%) }]{\text{N}_2\text{O}} \quad R\text{-R} \\
\text{THF, r.t.} & \quad \text{up to 99% yield}
\end{align*}$$

$R$ = aryl, alkenyl and alkyl groups
metal salt = for aryl and alkenyl coupling partners: Fe(acac)$_3$ or CoCl$_2$
for alkyl coupling partners: Li$_2$CuCl$_4$
$X$ = Cl, Br

**Selected examples:**

- **92% yield**
- **96% yield**
- **50% yield**
- **79% yield**
- **77% yield**
- **81% yield**

**Example for the oxidative cross-coupling of Grignard reagents:**

$$\begin{align*}
\text{PhMgBr} & + \text{ClMg} \xrightleftharpoons[\text{Li}_2\text{CuCl}_4(1 \text{ mol%}), \text{N}_2\text{O}]{} \text{THF, 0 °C} \quad \text{Ph} \\
(1 \text{ equiv}) & \quad \text{(2 equiv)} \quad \text{76% yield}
\end{align*}$$