Reductive Amination of Carbonyl Compounds on Nb$_2$O$_5$-Supported Ruthenium

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\begin{align*}

\text{O} & \quad \text{R}^1 \quad \text{R}^2 \\
\text{1 (0.5 mmol)} & \quad \text{Ru/Nb}_2\text{O}_5 (0.02 \text{ g}) \\
\text{MeOH (5 mL)} & \quad \text{NH}_3 (0.1 \text{ MPa}) \\
\text{363K, 1–18 h} & \quad \text{H}_2 (4 \text{ MPa}) \\
\end{align*}
\]

Results:

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\begin{align*}

\text{2a} & \quad \text{83\% yield} \\
\text{2b} & \quad \text{90\% yield} \\
\text{2c} & \quad \text{96\% yield} \\
\text{2d} & \quad \text{98\% yield} \\
\text{2e} & \quad \text{91\% yield H}_2 (2 \text{ MPa}) \\
\text{2f} & \quad \text{98\% yield} \\
\text{2g} & \quad \text{98\% yield} \\
\text{2h} & \quad \text{57\% GC yield} \\
\text{2i} & \quad \text{85\% GC yield} \\
\text{2j} & \quad \text{91\% yield} \\
\text{2k} & \quad \text{96\% GC yield} \\
\text{2l} & \quad \text{90\% yield} \\
\text{2m} & \quad \text{98\% yield} \\
\end{align*}
\]

Significance: Nb$_2$O$_5$-supported ruthenium nanoparticles (Ru/Nb$_2$O$_5$) were prepared by mixing Nb$_2$O$_5$ with an aqueous solution of Ru(NO)(NO$_3$)$_3$, followed by treatment under flowing H$_2$/argon at 673 K (eq. 1). Ru/Nb$_2$O$_5$ promoted the reductive amination of carbonyl compounds 1 with NH$_3$ and H$_2$ to give the corresponding primary amines 3 in ≥98% yield (eq. 2).

Comment: Ru/Nb$_2$O$_5$ prevented the formation of secondary amines and undesired hydrogenated byproducts. Ru/Nb$_2$O$_5$ was characterized by means of SEM, STEM, XPS, TPR, XRD and FT-IR analyses. Ru/Nb$_2$O$_5$ was recovered and reused three times without loss of its catalytic activity (2f; first reuse: 99% yield; second reuse: 93%; third reuse: 94%).