Rhodium Nanoparticle Catalysts Stabilized with Modified Polyvinylpyrrolidones

**Significance:** Rhodium nanoparticle catalysts coated with a modified polyvinylpyrrolidone (PVP) were developed. The Rh nanoparticles (NPs) coated with 1 (1-Rh) exhibited thermal and catalytic stability compared to Rh NPs coated with PVP (PVP-Rh). Hydrogenation of aromatic substrates was performed with 1-Rh, or 2-Rh to give the corresponding cyclohexanes.

**Comment:** Rh NPs were characterized by X-ray photoelectron spectrometry (XPS), transmission electron microscopy (TEM), and high-resolution transmission electron microscopy (HRTEM). Catalyst 1-Rh was reused without loss of catalytic activity in the hydrogenation of phenol (14 times) and toluene (8 times) while PVP-Rh showed significant loss of catalytic activity.

**Preparation of rhodium nanoparticles (Rh NPs):**

1. **1-Rh** (1 x 10⁻³ mmol, stabilizer: Rh = 20:1) with H₂O (1 mL), H₂ (20 atm), 60 °C, 2 h

2. **2-Rh** (1 x 10⁻³ mmol, stabilizer: Rh = 20:1) with [bmim][BF₄] (1 mL), H₂ (20 atm), 60 °C, 2 h

**Chemical Structures:**

- PVP: polyvinylpyrrolidone
- omim⁺: 1-methyl-3-octylimidazolium
- PVP-Rh, 1-Rh, 2-Rh

**Equations:**

$$\text{PVP-Rh, 1-Rh, 2-Rh}$$

$$\text{H₂O (1 mL), H₂ (20 atm), 60 °C, 2 h}$$

$$\text{99.8% yield}$$

$$\text{0.1% yield}$$

$$\text{44.2% yield}$$

$$\text{55.7% yield}$$

$$\text{99% yield}$$

$$\text{69% yield}$$

$$\text{95% yield}$$

$$\text{97% yield}$$

$$\text{[bmim][BF₄]: 1-butyl-3-methylimidazolium tetrafluoroborate}$$

$$\text{[C₂OHmim][BF₄]: 1-(2-hydroxyethyl)-3-methylimidazolium tetrafluoroborate}$$